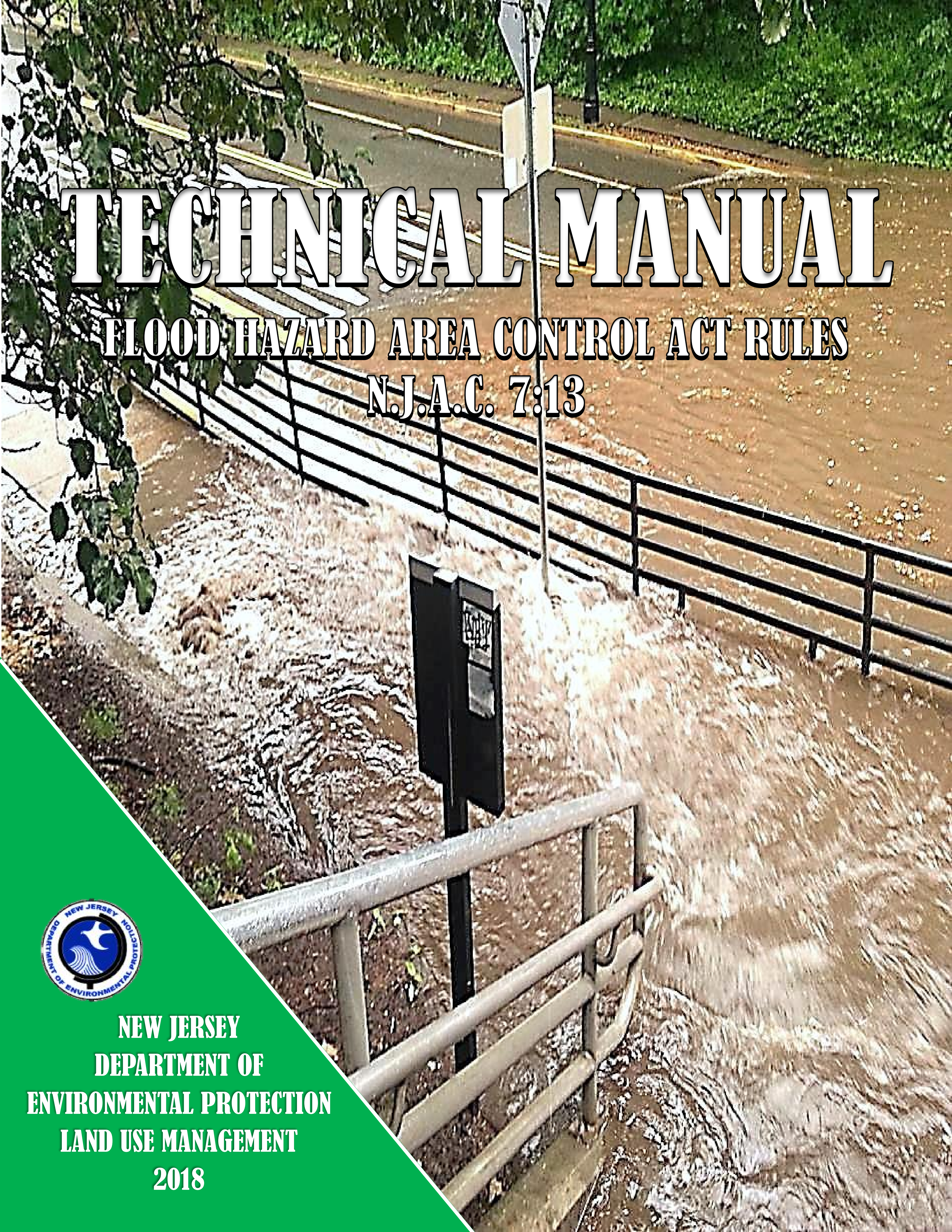
TECHNICAL MANUAL

FLOOD HAZARD AREA CONTROL ACT RULES

N.J.A.C. 7:13



NEW JERSEY
DEPARTMENT OF
ENVIRONMENTAL PROTECTION
LAND USE MANAGEMENT
2018

This technical manual was developed by NJDEP Land Use Management's Office of Policy Implementation and Division of Land Use Regulation with input from internal and external stakeholders. The Department recognizes and appreciates all of the time, effort, and talents of its staff and stakeholders that participated in this endeavor.

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SECTION 1 INTRODUCTION

The Flood Hazard Area Control Act (FHACA) Rules, N.J.A.C. 7:13, implement the Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 et seq., and satisfy the State's statutory directive to "adopt land use regulations for the flood hazard area, to control stream encroachments, to coordinate effectively the development, dissemination, and use of information on floods and flood damages that may be available, to authorize the delegation of certain administrative and enforcement functions to county governing bodies and to integrate the flood control activities of the municipal, county, State and Federal Governments" (N.J.S.A. 58:16A-50b).

Unless properly controlled, development within flood hazard areas can exacerbate the intensity and frequency of flooding by reducing flood storage, increasing stormwater runoff, and obstructing the movement of floodwaters. In addition, structures that are improperly built in flood hazard areas are subject to flood damage and threaten the health, safety, and welfare of those who use them. Furthermore, healthy vegetation adjacent to surface waters is essential for maintaining bank stability and water quality. The indiscriminate disturbance of such vegetation can destabilize channels, leading to increased erosion and sedimentation that exacerbates the intensity and frequency of flooding. The loss of vegetation adjacent to surface waters also reduces filtration of stormwater runoff and thus degrades the quality of these waters.

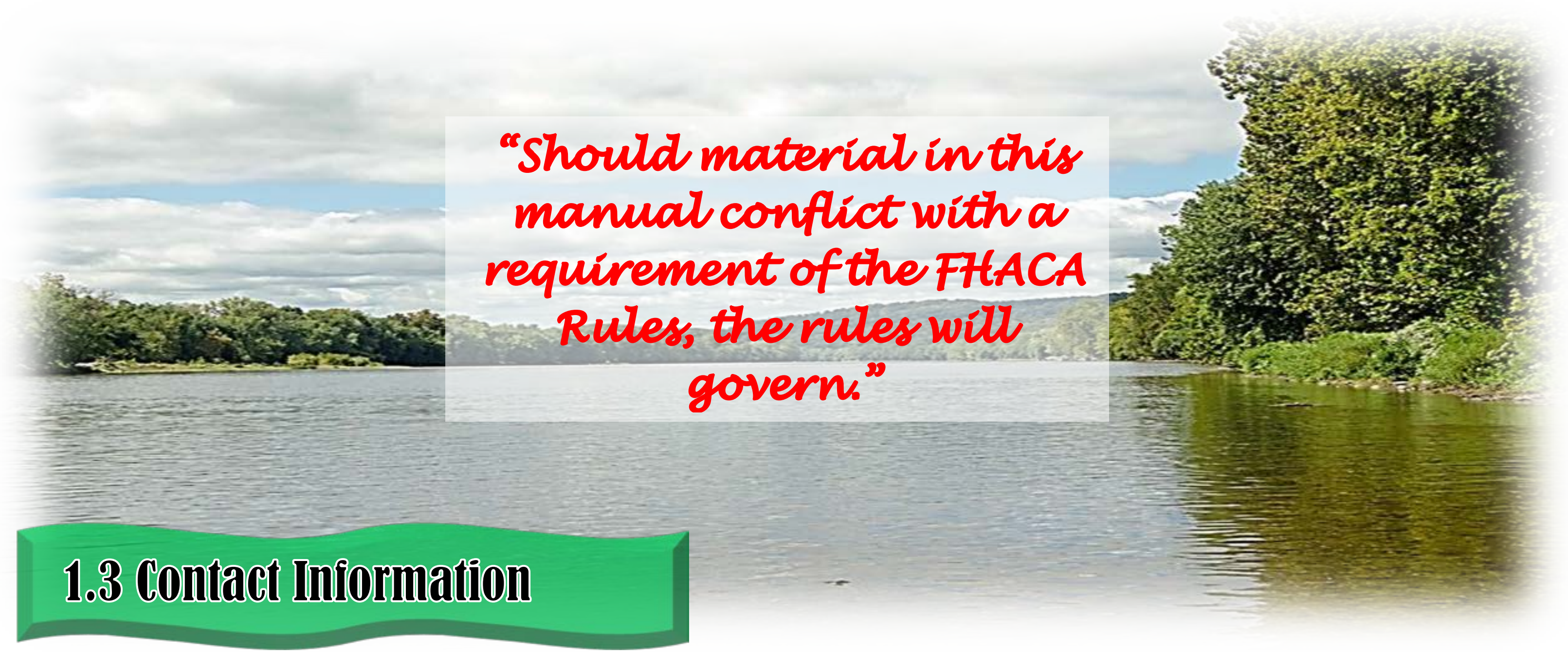
N.J.A.C. 7:13 therefore incorporates stringent standards for development in flood hazard areas and adjacent to surface waters in order to mitigate the adverse impacts to flooding and the environment that can be caused by such development.

1.1 Purpose of this Manual

The FHACA Rules are designed to be both highly descriptive and, to a certain extent, prescriptive. All the design and construction standards related to undertaking a regulated activity in a flood hazard area or riparian zone are contained within the various sections of the rules. The purpose of this manual, which is one of a series of technical manuals produced by the Department in accordance with N.J.S.A. 13:1D-111 et seq., is to assist applicants in obtaining any approvals that may be necessary for an activity under the jurisdiction of the FHACA Rules. The material presented here is intended to explain the standards of the rules and to provide guidance on how to meet those standards. This manual is in no way intended to replace or supersede these standards. Should material in this manual conflict with a requirement of the FHACA Rules, the rules will govern.

1.2 How to Use this Manual

This manual has been designed so that necessary information can be accessed as quickly and efficiently as possible, allowing the reader to bypass any material that may not apply to a particular activity or situation. For those reading this manual on a computer, internal and external links are provided to help navigate effectively through the content. Any section or subsection of this manual can also be accessed directly by clicking on the section or subsection title in the Table of Contents, which can be reached from any place in the manual by clicking the link found at the bottom of each page. An online copy of the FHACA Rules may also be accessed from the bottom of each page. Numerical references and website addresses have been included for those who are utilizing a hard copy of this manual.



1.3 Contact Information

Postal address:

State of New Jersey
Department of Environmental Protection
Division of Land Use Regulation
Mail Code 501-02A P.O. Box 420
Trenton, New Jersey 08625-0420

Telephone: (609) 777-0454
Website: www.nj.gov/dep/landuse
Email: LURTechSupport@dep.nj.gov

Street address (for meetings and hand delivery of material):

State of New Jersey
Department of Environmental Protection
Division of Land Use Regulation
501 East State Street, Second Floor
Trenton, New Jersey 08609

SECTION 2
RULE APPLICABILITY

Three steps are necessary to determine whether the FHACA Rules apply to a proposed activity.

STEP 1

Determine if the proposed activity is located near a water feature that is regulated by these rules. Surface waters subject to the FHACA Rules are referred to as *regulated waters* and are defined at N.J.A.C. 7:13-2.2 (see Section 2.1).

STEP 2

If a nearby water feature is regulated, determine if the proposed activity lies within the flood hazard area or riparian zone of that regulated water. The flood hazard area and the riparian zone comprise the *regulated areas* of these rules, as described at N.J.A.C. 7:13-2.3 (see Section 2.2).

STEP 3

If the proposed activity lies within a regulated area, determine if the proposed activity is a *regulated activity*, as defined at N.J.A.C. 7:13-2.4 (see Section 2.3).

If a proposed activity is a regulated activity located within the flood hazard area and/or riparian zone of a regulated water, a flood hazard area permit or authorization is required prior to the start of any construction, as discussed in Section 2.4.

Applicants who need assistance to determine if a flood hazard area permit or authorization is necessary may request an applicability determination from the Department. Applicability determinations are described in Section 2.5.

2.1 Regulated Waters

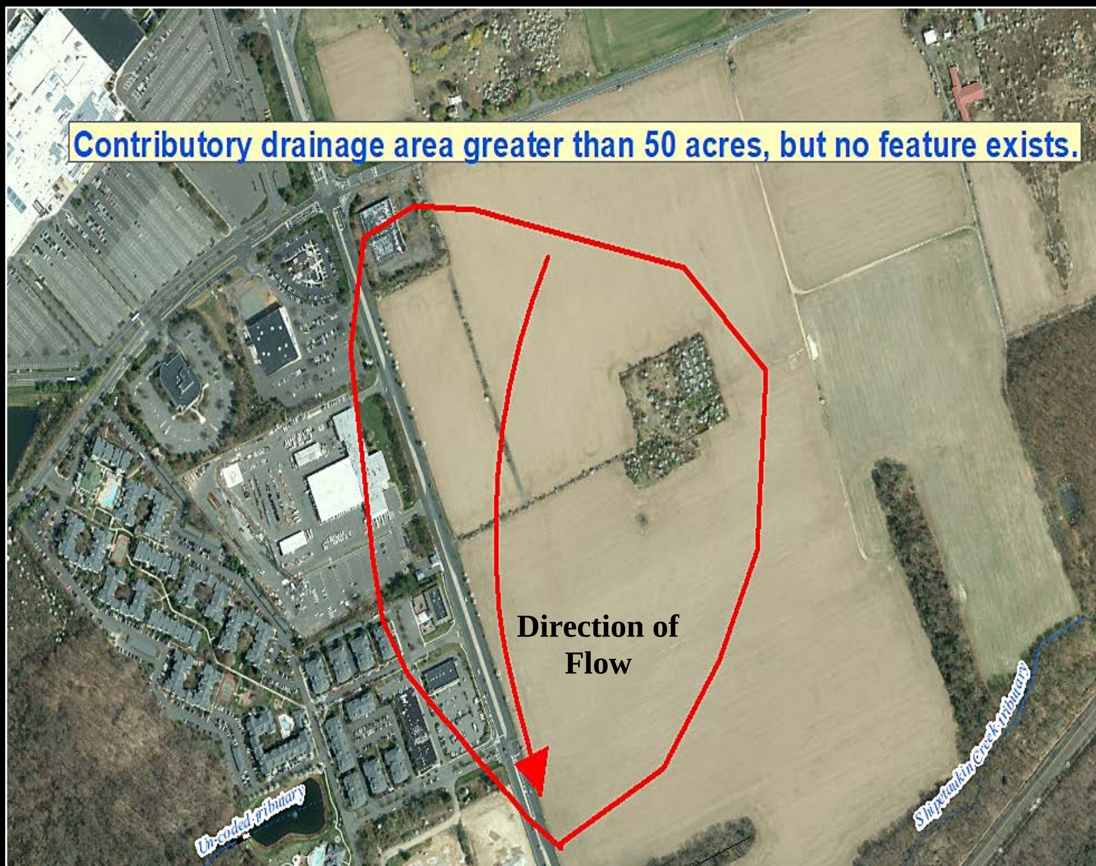
The FHACA Rules apply only when a surface water ("water") is present. The rules define a *water* as "a collection of water on the surface of the ground, including, but not limited to, a bay, brook, creek, ditch, lake, pond, reservoir, river, or stream. A water also includes the path or depression through which the water flows or is confined."

A water can be naturally occurring, or it may be the result of human activity, in which case it is referred to as *manmade*. If a water was naturally occurring at some point in the past but has been piped, relocated, or otherwise modified, that water is still considered a naturally occurring water under the FHACA Rules. However, an underground pipe or culvert that conveys stormwater runoff is not considered a water unless the pipe or culvert was constructed to enclose, replace, or divert a naturally occurring water. Since determining whether a feature was naturally occurring may be necessary to ascertain if it is considered a water, Section 2.1.2 discusses how to differentiate naturally occurring waters from manmade waters.

Not all features that meet the definition of a water fall under the jurisdiction of the FHACA Rules. A water that is subject to the FHACA Rules is called a *regulated water*. Under N.J.A.C. 7:13-2.2, all surface waters in New Jersey are regulated with four exceptions – manmade canals, coastal wetlands, certain segments of water that have a drainage area of less than 50 acres, and water-filled depressions created in dry land. Each exception is described in detail in Section 2.1.1. If a water does not meet one of these exceptions, it is considered a regulated water for the purposes of the FHACA Rules.

Since a water's drainage area can be crucial to determining if that water is regulated, Section 2.1.3 explains how to determine drainage area. Although certain waters with a drainage area of less than 50 acres are not regulated, all waters that drain 50 acres or more are regulated waters. However, it should be noted that situations exist where there is a large contributing drainage area but a surface water feature does not form. This may be due to underlying geology or soil type, land coverage, or other factors. For example, a large agricultural field may have an up-gradient drainage area greater than 50 acres, but no water feature exists within or adjacent to the farm field (see Figure 2.1 on the next page). Although such cases are uncommon, the FHACA Rules do not apply in these situations because, as mentioned above, the rules only apply when a water is present.

Figure 2.1: Site with No Water Feature Present and a Drainage Area of Greater Than 50 Acres



Where a water is present but is not regulated, the FHACA rules still apply if the non-regulated water passes through the flood hazard area or riparian zone of a separate water that is regulated. Flood hazard areas and riparian zones are described in Section 2.2.

Lastly, while the FHACA Rules do not apply to freshwater wetlands, a regulated water within the wetland's boundaries would be subject to the rules, as illustrated by Figure 2.2 on the following page. For an explanation of the application of the FHACA Rules to coastal wetlands, see Section 2.1.1 below.

Figure 2.2 depicts a regulated water with a drainage area greater than 50 acres that flows through a freshwater wetlands complex. No discernible channel exists within the wetlands, so that segment of the water would not be regulated if the water drained less than 50 acres, as described in Section 2.1.1. The centerline of the regulated water has been approximated within the wetland, as described in the definition of *top of bank* (see Section 6.2 of this manual), and the riparian zone limits were then measured outward from the approximated top of bank. Riparian zone limits are not measured outward from the wetland boundary since the wetland itself does not possess a riparian zone.

Figure 2.2: A Regulated Water Passing Through a Freshwater Wetland Complex

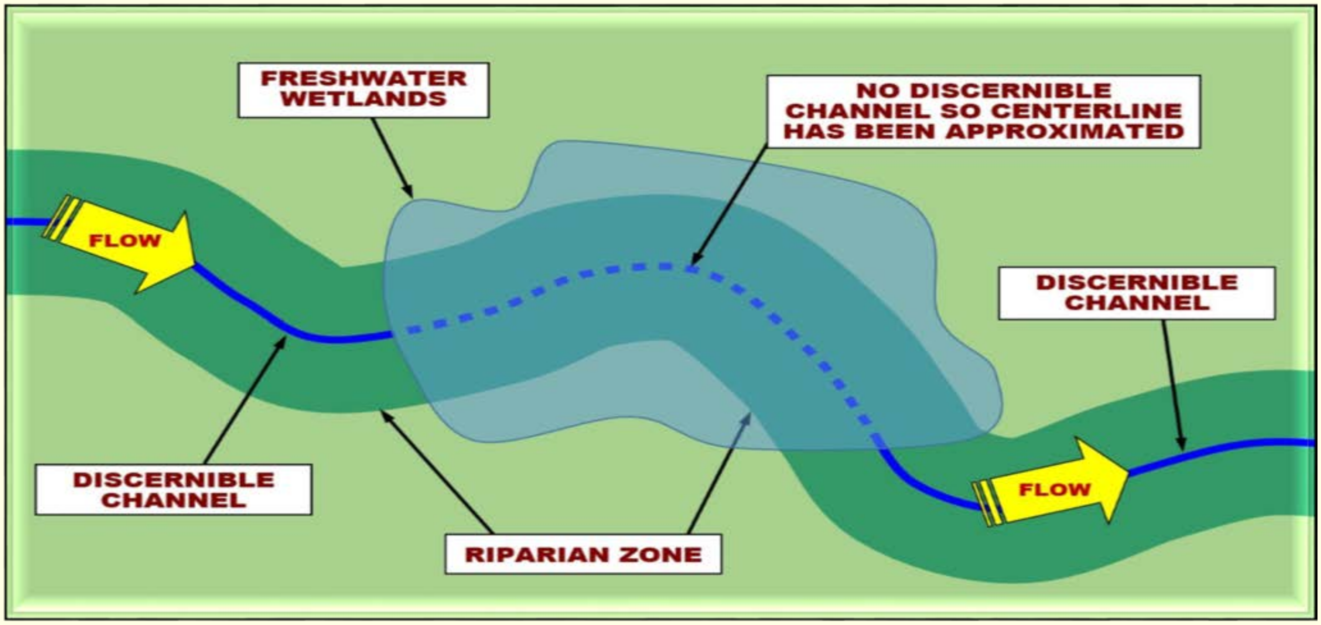
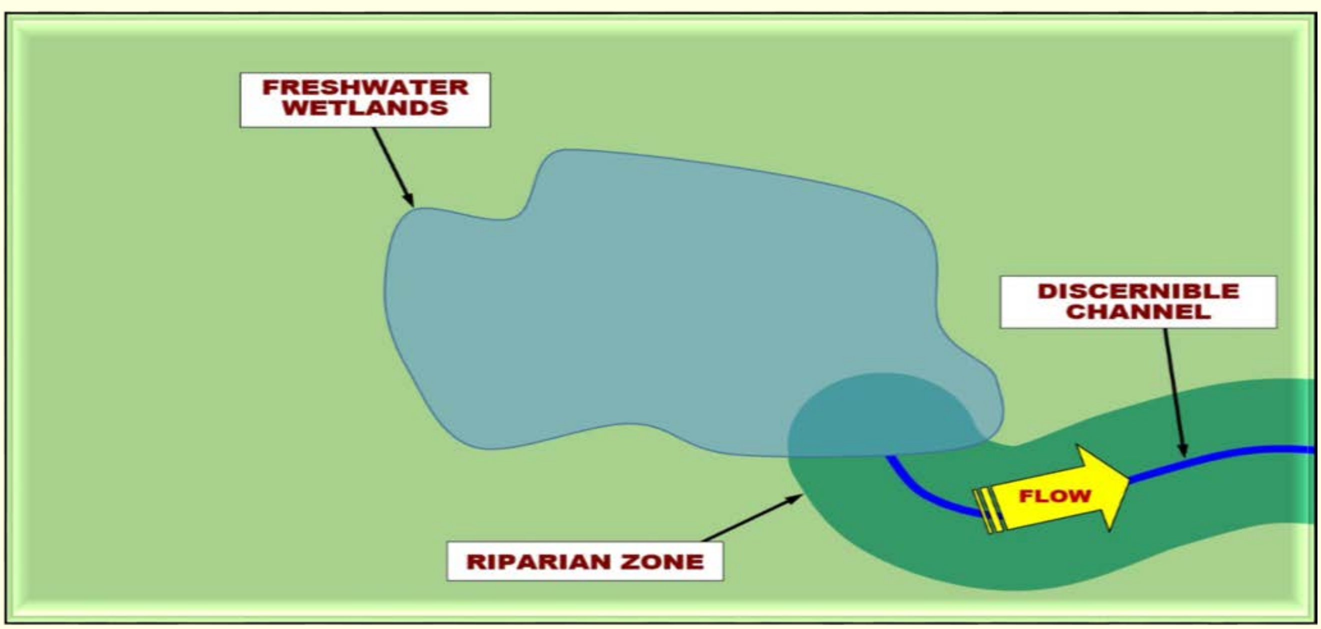


Figure 2.3, on the other hand, depicts the same freshwater wetlands complex without any regulated water flowing into it. Since there is no regulated water upstream of the wetlands, there is no approximated centerline within the wetlands, and the riparian zone exists only along the regulated water that flows out of the wetlands.

Figure 2.3: A Regulated Water Flowing Out of a Freshwater Wetland Complex



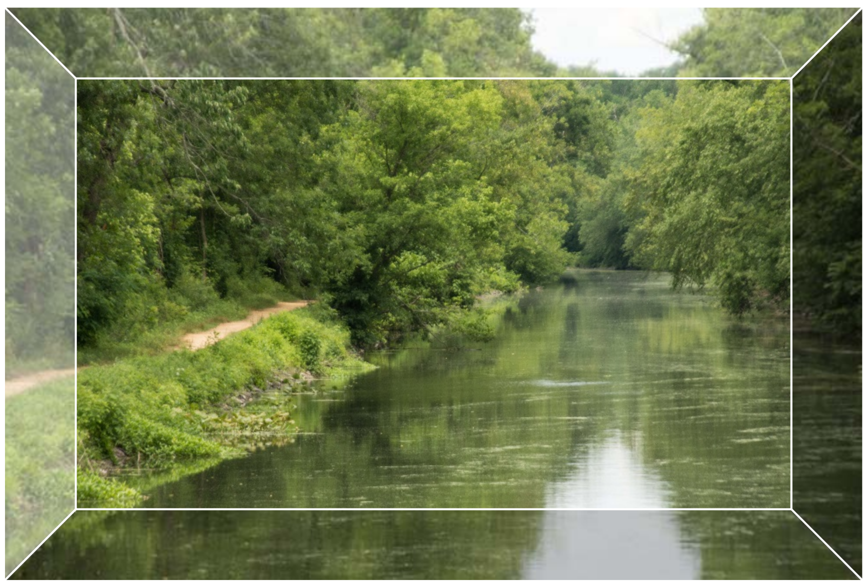
2.1.1 Exceptions

As mentioned above, all surface waters are regulated under the FHACA Rules with the following four exceptions, each of which is described in further detail below:

- Manmade canals
- Coastal wetlands regulated under the Wetlands Act of 1970 (N.J.S.A. 13:9A-1 et seq.)
- Segments of water that have a drainage area of less than 50 acres, **provided** they do not possess a discernible channel, are confined within a lawfully existing, manmade conveyance structure or drainage feature, and/or are not connected to a regulated water by a channel or pipe
- Water-filled depressions created in dry land as a result of a construction or remediation activity and any pits excavated in dry land to obtain fill, sand, or gravel

Manmade Canals

A *canal* is a waterway created, primarily for boats, through land areas by cutting and dredging or other human construction techniques. Canals do not include any man-altered naturally occurring waters (see Section 2.1.2). Some examples of canals in New Jersey that are not considered regulated waters are the Delaware and Raritan Canal, extant portions of the Morris Canal, the Cape May Canal, and the Salem Canal.



Coastal Wetlands

The Wetlands Act of 1970 resulted in the creation of coastal wetlands maps that depict the location of coastal wetlands within the State. The coastal wetland maps are listed in Appendix D of the Coastal Zone Management (CZM) Rules.

Although areas mapped as coastal wetlands are not regulated waters under the FHACA Rules, a regulated water (such as a stream) may pass through a coastal wetland. Generally, such a water would possess a flood hazard area and/or a riparian zone (see Section 2.2). However, when a regulated water flows into or through a coastal wetland, there is no riparian zone within the wetland (see Figure 6.18 in Section 6.3 of this manual), unlike when a regulated water flows into or through a freshwater wetland (see Figure 2.2 above).

However, relevant flood hazard area standards would apply within coastal wetlands since tidal flood hazard areas in New Jersey are created by inundation from the ocean and associated bays. For example, if a flood hazard area or coastal permit were granted to construct a house within coastal wetlands, the riparian zone standards of the FHACA Rules would not apply to the house but the elevation standards for the lowest floor of the building would apply (see Section 9 of this manual for the requirements for buildings).

Water Features Draining Less Than 50 Acres

Water features possessing a drainage area of less than 50 acres that are not regulated under the FHACA Rules include features without a discernible channel, features within a manmade conveyance structure, and isolated features. All three types of features are described below. If the drainage area of any of these features is greater than 50 acres, the feature is a regulated water irrespective of whether the feature has a discernible channel, is manmade, or is isolated. See Section 2.1.3 for information on how to determine the drainage area of a feature.

Features without a Discernible Channel

If a water feature draining less than 50 acres does not possess a discernible channel, it is not considered a regulated water under N.J.A.C. 7:13-2.2(a)3i. A channel must contain both a defined bed and defined banks. Linear topographic depressions and other flow paths may not be sufficient to trigger jurisdiction under the FHACA Rules if no discernible bed and banks are associated with them.

For example, a feature that meets the definition of a swale in the Freshwater Wetlands Protection Act (FWPA) Rules at N.J.A.C. 7:7A-1.3 is not considered a regulated water under the FHACA Rules since, according to this definition, a swale drains less than 50 acres and does not contain defined bed and banks. Therefore, if a feature is designated as an ordinary resource value swale in a Freshwater Wetlands Letter of Interpretation, it can be assumed that it is not a regulated water under the FHACA Rules. Figure 2.4 on the next page shows an example of a swale.

Figure 2.4: A Swale

A variety of factors are used to determine whether defined bed and banks are present. The bed is typically considered the path through which water flows, either continuously or intermittently. Generally, if water flows continuously, the bed of a feature is evident. However, for features where water flows intermittently, the bed is not always as easy to discern. In such cases, indicators that suggest surface water flow may be observable within the bed during dry periods, including:

⇒ Drift marks, wrack lines, bent vegetation, or other indicators that water is moving through an area

⇒ Stained leaves or water marks on the stems or trunks of woody vegetation

⇒ Sediment bars or silt deposits

⇒ Presence of water pools or remnant puddles

⇒ Position of the area in question within the overall landscape

In addition to having a bed, the channel must also possess a discernible bank. A bank is typically the sloping land adjacent to a waterway, and it forms the "walls" of the channel. For a defined bank to be present, there must be an observable vertical or upward break in the land directly adjacent to the bed of a water feature. A subtle, shallow topographic break, as shown in Figure 2.5 on the next page, is likely not significant enough to be considered a bank. Therefore, this feature would not constitute a regulated water if its drainage area is less than 50 acres because it does not have a discernible bank.

Figure 2.5: A Channel Without a Discernible Bank

Features within a Manmade Conveyance Structure

If a feature draining less than 50 acres is manmade, it is not considered a regulated water under the FHACA Rules. A water that is entirely contained within a manmade conveyance structure, such as a ditch, pipe, culvert, hard-armored channel, or stand-alone stormwater basin, may be manmade and therefore would not be regulated if it drains less than 50 acres. However, many naturally existing watercourses that drain less than 50 acres have been subjected to alterations like ditching, piping, culverting, or hard-armoring. Such watercourses, which are considered man-altered rather than manmade, are regulated waters. For information on how to determine whether a feature is manmade or man-altered, see Section 2.1.2.

Irrespective of the size of the drainage area, an underground pipe or culvert that conveys stormwater runoff is not regulated under the FHACA Rules because it is not considered a water under N.J.A.C.

7:13-1.2. However, if the pipe or culvert was constructed to enclose, replace, or divert a naturally occurring water, the water is considered regulated.

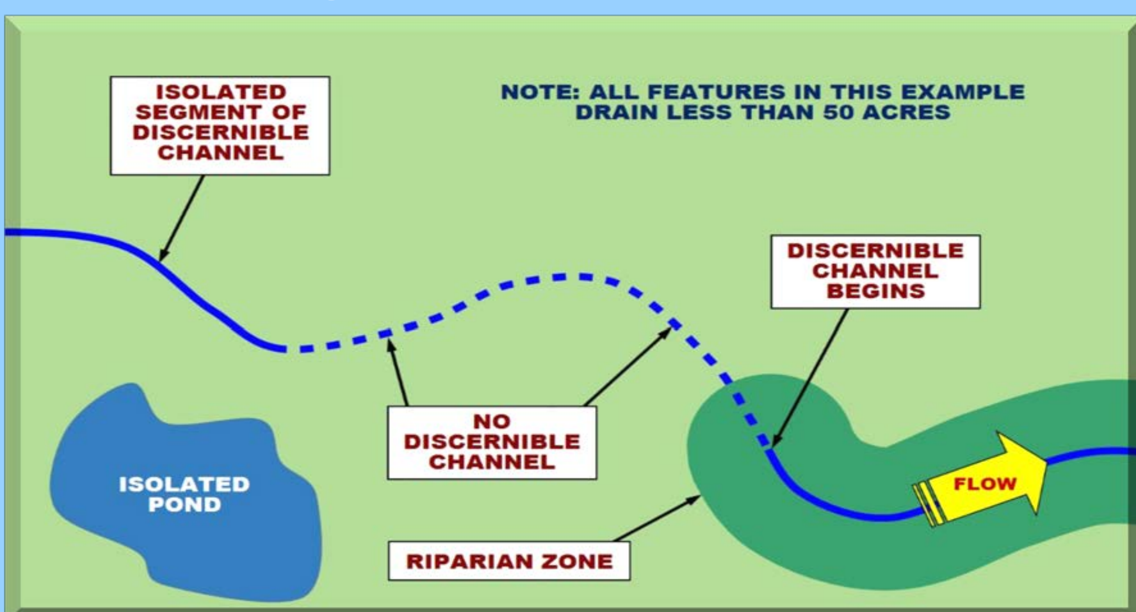
Isolated Features

If a water feature draining less than 50 acres is not connected to another regulated water by a pipe or channel, it is not a regulated water. The most typical type of waters that fall into this category are small, isolated ponds, such as would be used for irrigation, and small streams that run for a short distance and disappear into the ground, such as in areas with sandy soils, glacial boulder fields (where water flows underneath rocks but not under the surface of the ground), or Karst topography (an irregular landscape formed by the dissolution of soluble rocks and therefore characterized by sinkholes, underground streams, and caverns).

However, this category would also include isolated portions of a channel within a headwater that are not connected to the downstream regulated water. For example, a headwater area may contain a segment of defined channel that later dissipates or disappears downgradient. This channel may reform further downslope and continue uninterrupted until it has a drainage area of 50 acres. The portion of the up-gradient channel that was isolated from the regulated water would not be regulated since it is not connected to a regulated water by a channel. See Figure 2.6 below for an illustration of an isolated channel.

It should be noted that for a channel to be considered isolated, there must be a significant interruption in the channel due to geology, topography, or hydrography. Minor interruptions in the channel due to physical objects, such as rock piles, fallen trees, or man-made structures (i.e., dams, footbridges, trails, unimproved roads) would not be sufficient for the Department to determine that a channel is isolated.

Figure 2.6: An Isolated Channel



Water-Filled Depressions Created in Dry Land

This exception includes permanently ponded depressions that have resulted from construction or remediation activities or from the excavation of land to obtain fill, sand, gravel, or rock.

These areas are not regulated, regardless of the drainage area (see Section 2.1.3) or the size of the feature, unless both of the following occur:

1. The construction or excavation operation is abandoned.
2. The water feature is considered a "water of the United States" as defined in the Freshwater Wetlands Protection Act Rules. The Department defers to the United States Environmental Protection Agency for these determinations.

2.1.2 Determining if a Water is Manmade

A manmade water may be regulated under the FHACA Rules. In certain cases, determining if a manmade water is regulated depends upon determining if the feature is truly manmade or if it was a natural stream that has been altered by human activity. For example, as mentioned above, an underground pipe or culvert that conveys stormwater runoff is not regulated unless the pipe or culvert was constructed to enclose, replace, or divert a naturally occurring water. Likewise, a manmade canal is not regulated, but a naturally occurring water that has been man-altered so that it resembles a canal is regulated.

To determine if a water feature is naturally occurring, an applicant may rely on a variety of resources as well as the physical characteristics of the feature.

Examples of mapping resources, many of which are available through the Department's interactive mapping tool at http://www.nj.gov/dep/gis/geowebsplash.htm, include:

United States Geological Survey (USGS) Quadrangle Maps – These maps were created by USGS as a tool to view the nation's topography and natural features. USGS maps display intermittent and perennial water features as "blue-lines." USGS maps also show the topography of the surrounding area, including any linear convergence of surface water. Generally, manmade features are not depicted as "blue line" features on USGS maps. However, if a feature is absent on a USGS map, it should not be assumed that the feature is manmade as many headwater features similarly have not been mapped by the USGS. Since regulated water features may have been altered over time, historic USGS maps should be reviewed along with current maps.

Soil Survey – County soil surveys (bound paper books) from the 1970s can be a valuable resource for determining whether a water feature is or was historically present on a site. However, since these soil surveys were created to assist farmers in determining the most appropriate location for agricultural activities, they may not show waterways within forested or mountainous areas. Alternately, an intermittent stream as shown on a soil survey may merely be a low topographical area on a site with no evidence of water flow or a channel. However, if a feature appears within an existing wetland or floodplain and/or drains from or into an existing stream, further investigation is required. (Note: NRCS's online Web Soil Survey data does not indicate the presence of water features and therefore cannot be used to determine whether a regulated water is or was present.)

Vermeule Maps – Vermuele maps were created in the late 1800s and indicate whether a feature is natural or manmade since the mapping typically only shows natural streams. It should be noted that the Vermeule maps do not typically depict smaller tributaries or headwaters, so if a feature is absent from these maps, it should not be assumed that the water feature is manmade.

Aerial Photography – A review of historic aerial photography is critical in understanding the origin of a water feature. In particular, the 1930 aerials may provide a good indication of whether a feature is manmade or natural. If a feature shows on the 1930 aerials as a meandering channel within an area that is not being actively farmed, it can be assumed that the feature is likely natural. Features that are depicted on the 1930 aerials as linear (relatively straight) features may be ditches. However, it is essential to look both upstream and downstream of the site to determine whether a natural waterway exists. If a meandering waterway exists upstream of a linear feature, it is likely the feature was altered.

It should be noted that these resources should be used collectively when determining whether a feature is natural or manmade. The use of one or two resources may not be sufficient to make an educated decision on the origin of a water feature. Also, if the information provided by these sources is inconsistent, the applicant should contact the Department for guidance.

In addition to mapping resources, the physical characteristics of a feature can sometimes indicate whether the feature is natural or manmade. The following are typical characteristics of a natural waterway:

- The feature is meandering and not linear.
- Water is present within the feature at times other than rain events.
- There are no side casting or spoil piles adjacent to the banks.
- The surrounding land area consists of wetlands.
- The feature may contain biota such as larvae, fish and benthic invertebrates.

The following are characteristics of manmade waterways:

- The feature is linear in nature with little to no meandering.
- Water is not present or is only present during rain events. Note that this can also be a characteristic of intermittent streams, so it is essential to look for other characteristics as well.
- Side casts or spoil piles are evident along the banks of the feature.
- The feature is situated within or surrounded by uplands.
- Pipes or tile drains discharging into the feature are present.
- The waterway is a uniform depth and width.

It is important to note that these characteristics also apply to a naturally occurring waterway that has been man-altered. Therefore, the presence of these features alone is not sufficient to indicate that a waterway is manmade.

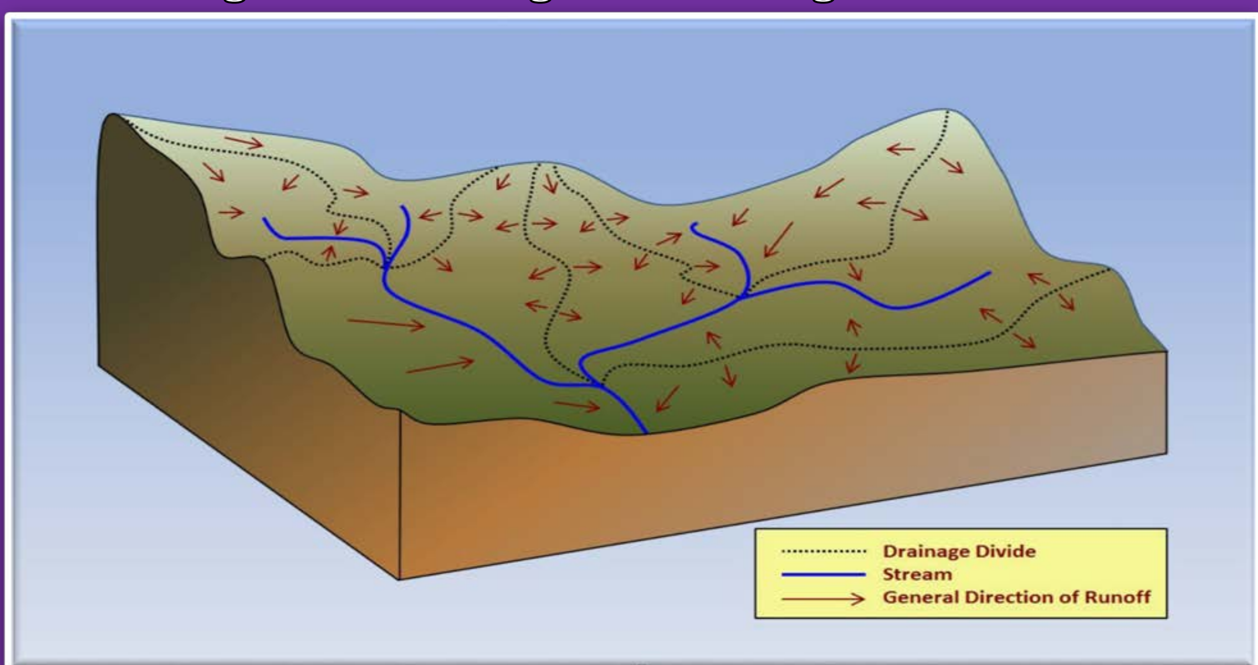
2.1.3 Determining Drainage Area

Determining the drainage area of a water is a key step in determining whether the feature is regulated under the FHACA Rules. It is also important in determining whether a regulated water possesses a flood hazard area, a riparian zone, or both (see Section 2.2) and in calculating flow rates (see Section 4.5.2 for more information on drainage areas as related to flow rate calculations).

Drainage area is defined in the FHACA Rules as the "geographic area within which water, sediments and dissolved materials drain to a particular receiving waterbody or to a particular point along a receiving waterbody." The term *drainage area* is generally synonymous with *watershed* in the sense that it describes the area of land from which a feature collects stormwater runoff. If a parcel is said to be located within the drainage area or watershed of a particular stream, stormwater runoff from that parcel will eventually reach that stream either through overland flow (flow across the surface of the ground or in streams) or via stormwater pipes. Groundwater flow is not considered to be part of a feature's drainage area.

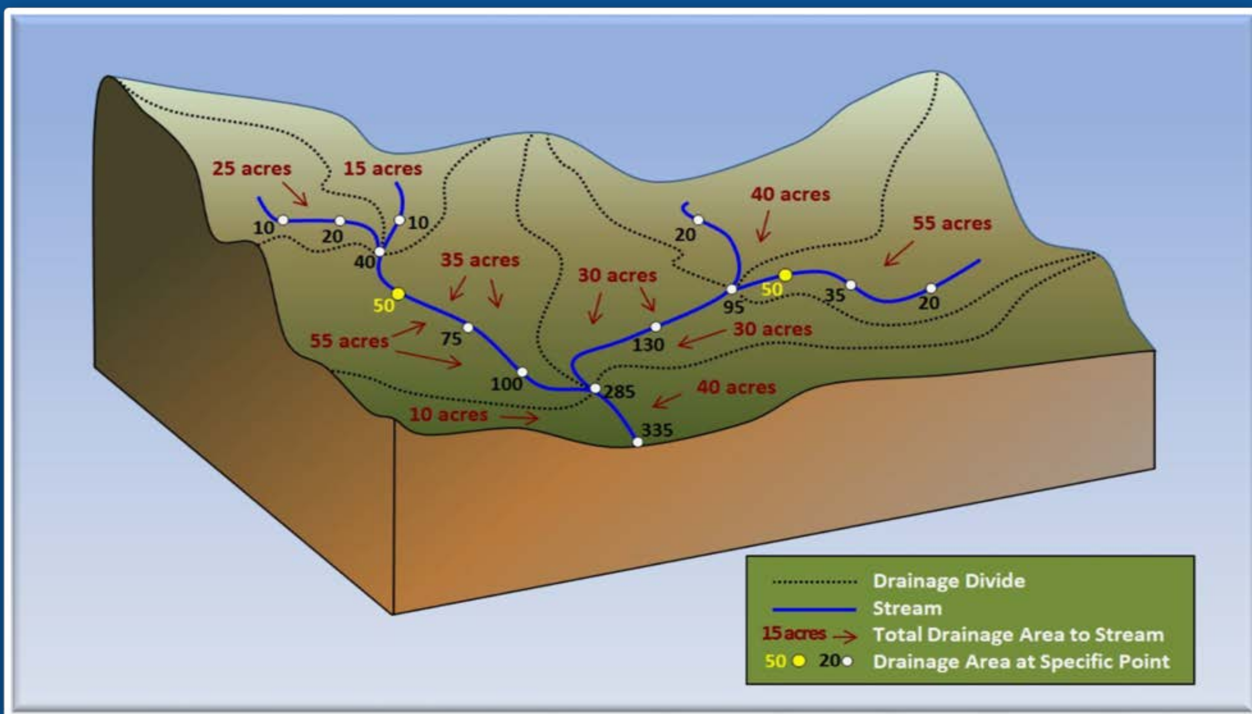
Drainage area is measured in acres or square miles and is a good indication of the relative size of a feature and its potential to cause flood damage. As the drainage area of a water increases, it will receive and ultimately convey more runoff. See Figure 2.7 below for an illustration.

Figure 2.7: Drainage Area of a Regulated Water



When determining the drainage area of a feature, a specific point along the feature must be selected because the drainage area increases as it flows down-gradient. Figure 2.8 below provides an illustration of this. For example, a stream may enter a property at a point where the drainage area is 30 acres and exit the site at a point where the drainage area is 70 acres. In such a case, the 50-acre threshold for possessing a flood hazard area (see Section 2.2) would be reached somewhere within the property.

Figure 2.8: Determining Drainage Area at a Specific Point along a Regulated Water



Therefore, determining the drainage area of a water requires knowledge of the contour of the land surrounding the feature, which may be acquired from topographic maps. USGS Quadrangle maps are available to the public and are generally helpful in determining drainage areas. USGS further provides a very useful interactive online tool at https://water.usgs.gov/osw/streamstats/new_jersey.html that can be used in many cases to determine the drainage area at a point along a water.

In cases where USGS mapping is unable to conclusively determine whether the drainage area of a water is greater or less than 50 acres, prospective applicants may seek to obtain more detailed topography from additional sources, such as aerial topography or LIDAR produced by government entities or site-specific topography produced by a New Jersey licensed professional land surveyor. Since USGS mapping is drawn at a scale of one inch equals 2,000 feet and generally depicts topography at 20-foot intervals, USGS mapping may not be able to capture small contours and other features at the edge of a drainage area. The Department will therefore rely on the best available data for determining the drainage area of a feature. In the absence of better data, the Department will rely on USGS mapping. However, newer topography that provides data in smaller contour intervals and at a bigger scale is preferred.

It should be noted that stormwater management improvements constructed within one watershed may in some cases collect runoff from a portion of a feature's drainage area and divert it to a different watershed. For example, a basin could be constructed to capture runoff from a portion of a drainage area and discharge it via stormwater pipes into a different stream. The Department is sometimes asked to consider removing such areas from the overall drainage area of a feature. However, while stormwater management devices, such as basins, are generally constructed to manage runoff from no greater than a 100-year storm and stormwater pipes do not typically convey runoff in excess of a 25-year storm, the FHACA Rules regulate the flood hazard area design flood, which is 25 percent larger than the 100-year event (see Section 4 of this manual). Therefore, even though stormwater devices may convey some runoff outside a feature's drainage area, some runoff – and possibly a considerable quantity of runoff – will still reach the regulated water in question during the flood hazard area design flood. Consequently, for the purposes of determining jurisdiction under the FHACA Rules, the Department rarely considers the drainage area of a water to be altered by the construction of stormwater management devices.

2.2 Regulated Areas

The FHACA Rules have authority over development activities within regulated waters as well as two distinct and overlapping areas of jurisdiction associated with the regulated waters – the flood hazard area and the riparian zone.

The *flood hazard area* is the area that is inundated by the flood hazard area design flood, which is the flood regulated by the State under the FHACA Rules. It is equal to the 100-year flood plus a factor of safety in non-tidal areas (see N.J.A.C. 7:13-3). A flood hazard area exists along every regulated water that has a drainage area of 50 acres or more. If a regulated water has a drainage area of less than 50 acres, the water does not have a flood hazard area that is regulated under the FHACA Rules. Section 4 of this manual describes flood hazard areas in detail and explains the requirements for regulated activities within a flood hazard area. For information on how to determine the drainage area of a water, see Section 2.1.3 above.

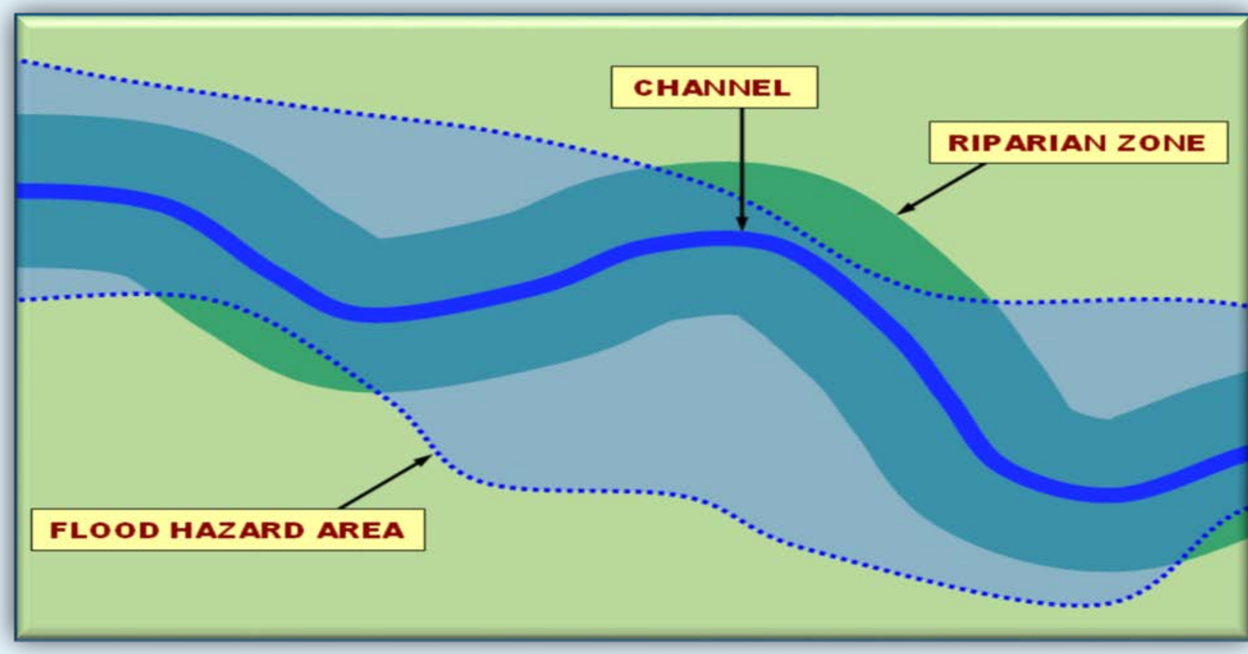
A property that lies in a flood hazard area is periodically inundated by floodwaters. Consequently, a certain volume of floodwater will occupy that property during a flood. That volume of floodwater is referred to as the *flood storage*. Flood storage on a site can be reduced by development, which in fluvial (non-tidal) areas, forces the water that would have occupied the site onto neighboring and downstream properties, worsening flood conditions on those properties. For this reason, the FHACA Rules include various restrictions on the volume of floodwater that can be displaced by development in fluvial areas (see N.J.A.C. 7:13-11.4). Section 5 of this manual discusses the standards for flood storage displacement.

The *riparian zone* is the land and vegetation within and adjacent to a regulated water, and it extends 50, 150, or 300 feet from the top of bank along both sides of the regulated water (see N.J.A.C. 7:13-4). Research has shown that vegetated areas adjacent to a watercourse help maintain water quality and temperature, stabilize banks, provide protection from flooding, and serve as wildlife habitat. The regulated water itself is also part of the riparian zone. Given the many important functions that a healthy riparian zone provides, adequately preserving such areas is essential to protecting New Jersey's natural resources and water supply. Therefore, under the FHACA Rules, a riparian zone exists along both sides of every regulated water, except those waters listed at N.J.A.C. 7:13-2.3(c)1 and in Section 6 of this manual.

Section 6 provides more detailed information about riparian zones, including how to determine the width of the riparian zone and how to apply the riparian zone standards of the FHACA Rules. If a regulated activity causes disturbance to riparian zone vegetation, certain standards apply to the activity and mitigation may be required. See N.J.A.C. 7:13-11.2 for individual permit standards related to riparian zone disturbance, and see N.J.A.C. 7:13-13 and Section 7 of this manual for the mitigation standards.

Some regulated waters have only a flood hazard area, all have a riparian zone except those listed at N.J.A.C. 7:13-2.3(c)1, and most have both. Figure 2.9 below illustrates how the flood hazard area and riparian zone overlap along a given waterbody. Note that while the riparian zone is a constant width from the channel, the flood hazard area varies in width according to the topography of the area.

Figure 2.9: A Flood Hazard Area and a Riparian Zone along a Regulated Water



2.3 Regulated Activities

As stated at N.J.A.C. 7:13-2.4, any action that includes or results in one or more of the following constitutes a regulated activity if undertaken in a regulated area (flood hazard area and/or riparian zone):

- **The alteration of topography through excavation, grading, and/or placement of fill**
- **The clearing, cutting, and/or removal of vegetation in a riparian zone (including areas containing vegetation for a portion of the year, such as agricultural areas that are periodically plowed and cultivated)**
- **The creation of impervious surface**
- **The storage of unsecured material**
- **The construction, reconstruction, repair, alteration, enlargement, elevation, or removal of a structure**
- **The conversion of a building into a single-family home or duplex, multi-residence building, or critical building**

If a proposed activity is not listed above, it does not require an approval under the FHACA Rules even if it is undertaken within a flood hazard area or riparian zone. However, all regulated activities occurring within a flood hazard area and/or a riparian zone require a permit or authorization (see Section 2.4).

Sections 9 through 14 of this manual contain more specific information on the following regulated activities: buildings, bridges and culverts, utility lines, bank stabilization, stream cleaning, and stormwater management.

2.4 Permit Requirement

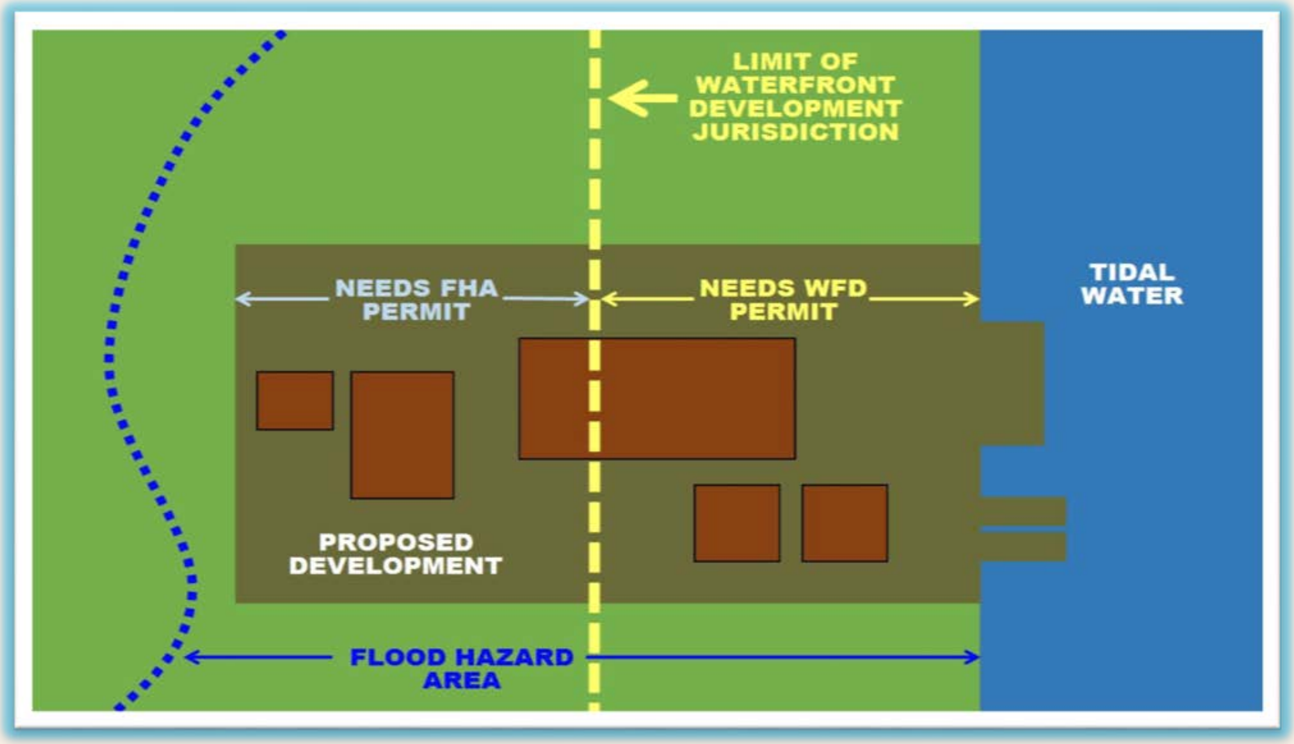
Before undertaking a regulated activity in a regulated area along a regulated water, a permit or authorization must first be obtained. The type of permit or authorization that is required will depend on the type of activity that is being proposed. The following types of permits and authorizations are available under the FHACA Rules, each of which are described in further detail in Section 3.1 of this manual:

A permit-by-rule	Section 3.1.1
An authorization under a general-permit-by-certification	Section 3.1.2
An authorization under a general permit	Section 3.1.3
An individual permit	Section 3.1.4
A coastal permit	Section 3.1.5
An emergency authorization	Section 3.1.6

It is important to note that a coastal permit must be obtained in lieu of a flood hazard permit if a regulated activity requires a CAFRA or waterfront development permit and occurs within the jurisdiction of the FHACA Rules. However, a site may require both a flood hazard area permit or authorization and a coastal permit. For example, the upland waterfront development area (defined in the CZM Rules at N.J.A.C. 7:7-2.4(a)3ii) outside of the CAFRA area (defined at N.J.S.A. 13:19-4) extends up to 500 feet inland from the mean high water line. If a project is proposed more than 500 feet from the mean high water line but within the flood hazard area, two approvals may be necessary. See Figure 2.10 on the following page.

Please note that a flood hazard area permit or authorization is required for any project located within the jurisdiction of both the FHACA Rules and the CZM Rules and which does not require a coastal permit. For example, the construction of a single-family house in the middle of a barrier island more than 150 feet from the mean high water line does not require a coastal permit. However, if the proposed house is located within a flood hazard area, which is very likely, a flood hazard area permit or authorization would be required for the house.

Figure 2.10: A Site Requiring Both a Flood Hazard Area Permit and a Coastal Permit



A limited number of projects may be *grandfathered,* meaning they are exempted from obtaining a flood hazard permit or authorization even if performed in a regulated area along a regulated water. These projects are typically those that received some type of approval from the Department or the local municipality prior to the enactment of the 2007 FHACA Rules. For the complete list of the exemption requirements, see N.J.A.C. 7:13-2.1(c).

Please note that any regulated activity under the FHACA Rules may also be subject to other Federal, State, and/or local rules, plans, and ordinances. The applicant is responsible for obtaining all necessary approvals for a proposed project.

2.5 Applicability Determinations

If it is unclear whether a particular activity is regulated under the FHACA Rules, a person may request an applicability determination, which is an optional service the Department provides to anyone who wants a written determination of whether or not a flood hazard area permit or authorization is necessary. Applicability determinations may be obtained for a segment of water or for one or more proposed activities, provided the determination does not require the Department to undertake a site inspection or review engineering calculations (see N.J.A.C. 7:13-2.5(b)). Applicability determinations are recommended when there is uncertainty as to whether an activity is regulated to avoid unintentionally undertaking unauthorized regulated activities and incurring potential liability.

There is no fee for applicability determinations, and the procedure for requesting an applicability determination is provided at N.J.A.C. 7:13-2.5. All requests for applicability determinations must include a completed application form as well as a copy of a USGS quad map and any available Department delineation or FEMA flood mapping. The applicable segment of water must be clearly indicated and/or the complete site must be outlined to scale on both the USGS quad map and the Department delineation or FEMA flood map.

To determine if a particular water is regulated, a copy of the best available topographic mapping for the drainage area of the water in question, with the limits of the drainage area depicted, is also required (see Section 2.1.3 for information on how to determine drainage area). To determine if a particular activity is regulated, the applicability determination request must also include a written description of the site and activity, color photographs of the proposed location of the activity, and site plans.

In some cases, the Department will be able to determine from this information whether the rules apply to a proposed water or activity, if the activity is eligible for a permit-by-rule (see Section 3.1.1 of this manual), or if an authorization or permit must be obtained. However, in certain cases it may not be possible to determine applicability without a verification of the riparian zone, flood hazard area, and/or floodway limits. In such a case, the Department will issue a letter stating that a verification must first be obtained to determine applicability. Verifications are discussed in Section 3.2 of this manual.

Applicability determinations are based on the FHACA Rules in effect and the information provided in the application concerning site conditions and proposed activities as of the date the determination is issued. Waters or proposed activities that were determined to be unregulated in the issued applicability determination may become regulated through any or all of the following:

- Subsequent amendments to the FHACA Rules
- Changes in site conditions
- Changes to the limits of the flood hazard area, floodway, or riparian zone
- Changes to proposed activities

The term of an applicability determination expires when any of the above-listed changes occurs. Note that the recipient of the applicability determination is responsible for determining whether any of these changes have occurred and should notify the Department of such changes by applying for a new applicability determination. The recipient may be liable for penalties resulting from any violation of the FHACA Rules resulting from activities conducted in reliance of an applicability determination where changes have occurred that render the determination inaccurate.

SECTION 3 PERMITS, AUTHORIZATIONS, AND VERIFICATIONS

Before any regulated activity may be undertaken in a regulated area, an authorization or permit is required under the FHACA Rules.

Types of authorizations and permits include:

- **Permits-by-rule**
- **General permits-by-certification**
- **General permits**
- **Individual permits**
- **Emergency authorizations**
- **Coastal permits**

The specific type of permit or authorization necessary for a given activity depends on the size, scope, location, and/or nature of the activity. Section 3.1 describes authorizations and permits, including an explanation of each type of authorization and permit available under the rules.

The FHACA Rules also provide for verifications, which establish flood elevations and the boundaries of regulated areas. Verifications are discussed in Section 3.2.

An application is required for most permits, authorizations, and verifications. Some common application requirements are addressed in Section 3.3.

If there are any questions regarding which permits, authorizations, and/or verifications may be required from the Department and/or what materials must be included with an application, further information is available on the Division of Land Use Regulation's website at http://nj.gov/dep/landuse/index.html. A *pre-application conference* may also be requested. A pre-application conference is a meeting with the Department to discuss the applicant's particular project and the application procedures and standards that will apply to that project. While pre-application conferences are not mandatory, they are recommended for large and/or complicated projects. Discussions or guidance offered by the Department at a pre-application conference do not constitute a commitment by the Department to approve or deny an application.

> THE PROCEDURES FOR REQUESTING AND SCHEDULING A PRE-APPLICATION CONFERENCE, AND THE INFORMATION REQUIRED AS PART OF THE REQUEST, CAN BE FOUND AT N.J.A.C. 7:13-17.

All permits and authorizations issued under the FHACA Rules include specific conditions, as explained in Section 3.4. Provided these conditions are observed, the applicant can perform the regulated activity as soon as the appropriate flood hazard authorization or permit has been obtained. However, applicants are not always prepared to begin a project immediately after obtaining approval, and certain projects may require a significant amount of time to complete. Since all authorizations, permits, and verifications (except permits-by-rule) have expiration dates, occasionally a project cannot be completed before the issued permit, authorization, or verification expires. Also, circumstances sometimes demand a project be modified after an authorization or permit is issued, site conditions may change after a verification is issued, or the owner may decide to sell the subject property. On occasion, the Department may discover that a permit, authorization, or verification was issued as a result of inaccurate information or that one of the conditions has been violated. For these reasons, the FHACA Rules include standards for modifying, transferring, extending, suspending, and terminating flood hazard area permits, authorizations, and verifications at N.J.A.C. 7:13-22.

The Department is also authorized to perform site inspections, regardless of whether a permit or authorization has been issued, as discussed in Section 3.5.

3.1 Types of Permits and Authorizations

Activities regulated under the FHACA Rules fall into two categories – those that are preapproved under the rules and those that must be approved by Department staff. Certain common activities that have a minimal impact on flooding and the environment, such as regular lawn maintenance and constructing a fence, may be "preapproved" under the rules, provided that strict requirements are met. The FHACA Rules include permits-by-rule (see Section 3.1.1), general permits-by-certification (see Section 3.1.2), and general permits (see Section 3.1.3) for these activities. This does not mean that all preapproved activities can be performed without notifying the Department. While no written documentation is required to perform an activity that qualifies for a permit-by-rule, applicants must receive an authorization from the Department before beginning activities approved under general permits-by-certification and general permits.

Anyone who is uncertain whether a proposed activity would qualify for a permit-by-rule, general permit-by-certification, or general permit is encouraged to obtain an applicability determination from the Department's Division of Land Use Regulation. The procedure for obtaining an applicability determination can be found in the rules at N.J.A.C. 7:13-2.5 and is also described in Section 2.5 of this manual.

More complex activities that do not meet the strict requirements of a permit-by-rule, general permit-by-certification, or general permit must be approved by Department staff under an individual permit (see Section 3.1.4). In certain circumstances, an applicant may obtain a coastal permit (see Section 3.1.5) or an emergency authorization (see Section 3.1.6) for an activity regulated under the FHACA Rules, both of which must also be approved by Department staff.

Different types of permits may be combined on a single site with certain limitations, as discussed in Section 3.1.7.

3.1.1 Permits-by-Rule

Permits-by-rule are available for activities that are minor in scope with the least impact on flooding and the environment. The FHACA Rules include permits-by-rule for 62 such activities, described at N.J.A.C. 7:13-7. These permits-by-rule can be classified into nine broad categories – general construction activities, buildings, water dependent activities, specific construction activities, utilities, roads, surveying activities, storage, and agricultural activities. Appendix A provides a list of activities authorized under a permit-by-rule arranged by category. Note that it is not sufficient to simply rely on the brief descriptions in this table to determine if a project is authorized under a permit-by-rule; since no prior written authorization is required before undertaking eligible activities, each permit-by-rule is tightly restricted with clearly defined limits provided at N.J.A.C. 7:13-7. If the activity cannot meet those limits, it is not approved under the permit-by-rule. If the activity cannot meet those limits, it is not approved under the permit-by-rule. See the explanation of permit-specific conditions in Section 3.4.

3.1.2 General Permits-by-Certification

General permits-by-certification are available for certain regulated activities that are slightly more complex than those activities eligible for a permit-by-rule and therefore require authorization through the Department's electronic permitting system at http://nj.gov/dep/online before they can be undertaken. However, like permits-by-rule, they include strict limitations, which allow the automated issuance of an approval or rejection. See Section 3.4 for an explanation of permit-specific conditions. There is no need for a case-by-case evaluation of whether the activity meets the tight conditions of the permit because the applicant must certify that it does, but the online process provides the Department with a complete record of the proposed activity, including the location and extent of the regulated activity and the applicant's and property owner's names, addresses, and contact information.

The FHACA Rules include general permits-by-certification for 15 activities, which are described at N.J.A.C. 7:13-8. These general permits-by-certification can be classified into seven broad categories – agricultural activities, environmental enhancement activities, buildings, sediment removal, maintenance and replacement activities, surveying or water monitoring, and alternative energy (solar panel) activities. Appendix B provides a list of the activities eligible for a general permit-by-certification organized by category.

Please note that if a general permit-by-certification is to be combined with a general permit authorization or an individual permit on the same site, the applicant must obtain the general permit-by-certification through the electronic permitting system and submit a separate general permit or individual permit application to the Department. At this time, only applications for a general permit-by-certification can be submitted via the online portal.

The Department provides application checklists for each type of general permit-by-certification on its website at http://www.nj.gov/dep/landuse/forms.html. Before beginning the online application process, the applicant must ensure that all application requirements have been met, including the requirement to provide public notice (see N.J.A.C. 7:13-19 for the public notice requirements). Some general permits-by-certification also require the applicant to obtain an engineering certification (see Section 3.3.1 for more information). While this document does not need to be submitted to the Department with the application, the applicant must be able to provide it to the Department upon request.

The following information is required as part of the online application:

1	**The number and activity for the applicable general permit-by-certification**
2	**The name (or some other identifier) of the proposed development or project**
3	**The specific location information for the proposed regulated activity or project**
4	**Information specific to the proposed project that relates to the requirements of the general permit-by-certification under which the application is being submitted (for example, the square footage of an addition proposed under general permit-by-certification 8)**
5	**Contact information for both the applicant and the property owner**

To start the process of applying for authorization under a general permit-by-certification, an applicant will first need to create a MyNewJersey account at http://www.state.nj.us. Then, access must be requested to the online permitting portal at http://nj.gov/dep/online where that account will need to be linked to the NJDEP Online Site. As part of the registration process, the applicant will need to obtain a certification PIN, which will be used for certifying all applications submitted through the NJDEP Online Site.

Once the applicant has registered and obtained a certification pin, the applicable permit-by-certification must be selected (see Figure 3.1 below), and all required information, such as site information, must be supplied (see Figure 3.2 below Figure 3.1).

Figure 3.1: Online Permitting Portal – General Permit-by-Certification Permit Selection Screen

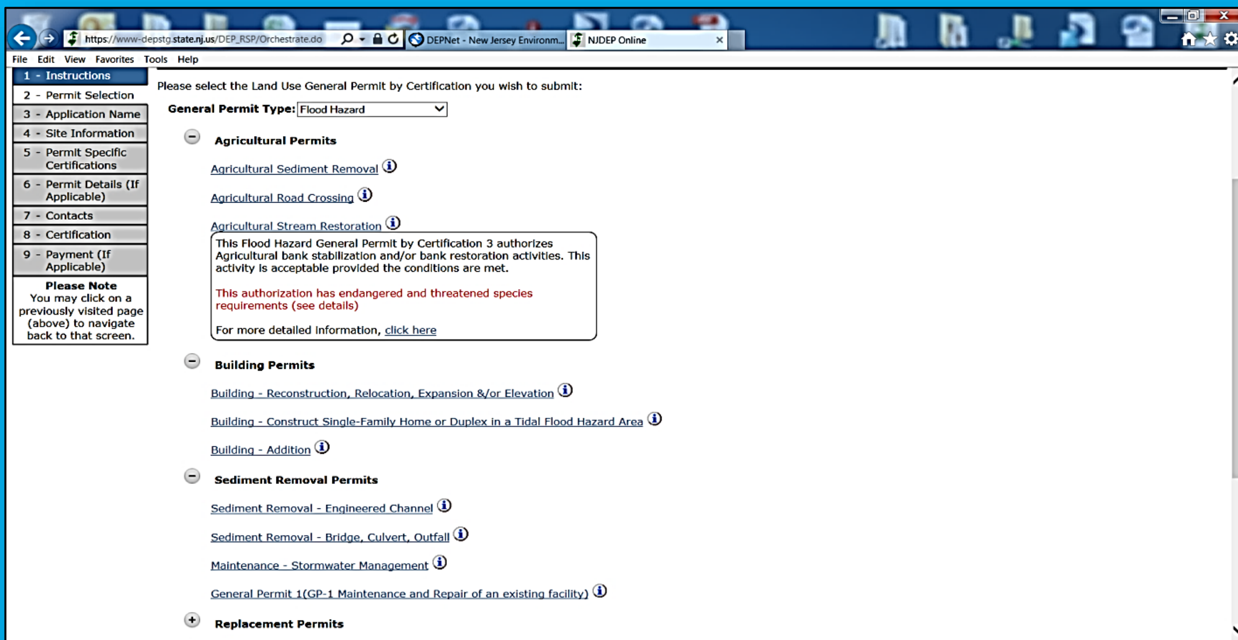
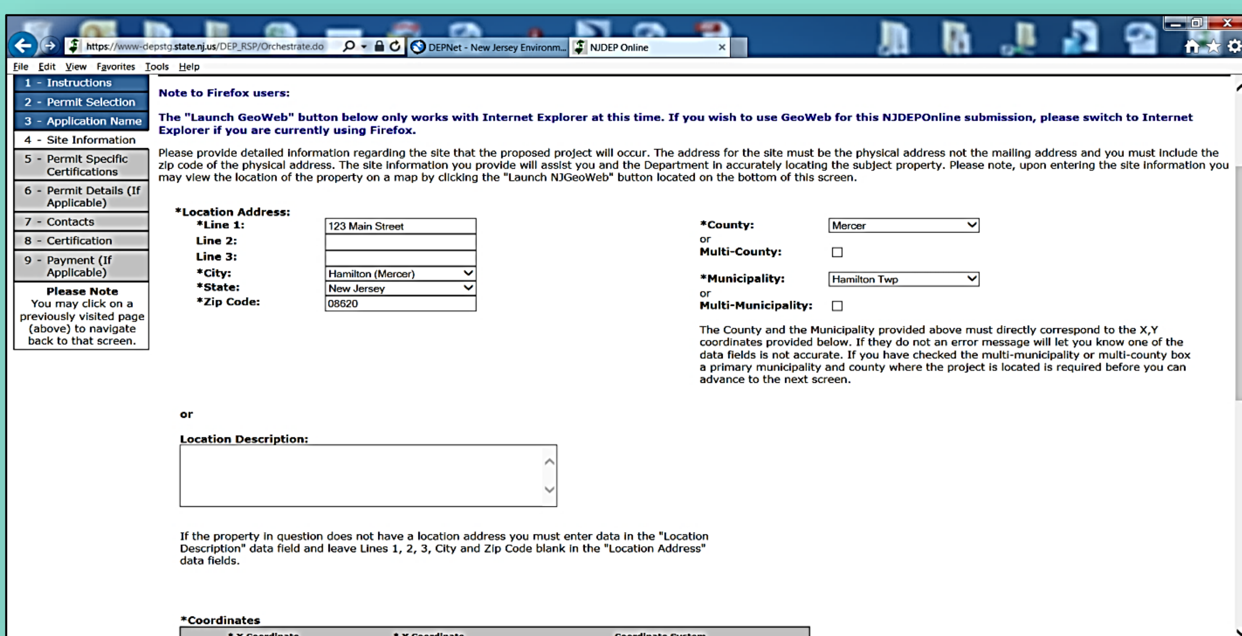


Figure 3.2: Online Permitting Portal – General Permit-by-Certification Site Information Screen



Next, the applicant must certify to **all** of the following, using the PIN that was issued upon registration with the online permitting system:

- ✓ **The site identified in the application is the actual location of the project site.**
- ✓ **Public notice of the application has been provided (see N.J.A.C. 7:13-19 for the public notice requirements).**
- ✓ **The applicant has obtained written consent from the property owner that the application can be made on the property owner's behalf.**
- ✓ **All conditions of the general permit-by-certification are or will be met.**

The applicant must also submit the appropriate application fee for the general permit-by-certification, except for general permits-by-certification 4 and 5, which do not require an application fee.

Once the application process is successfully completed, the authorization will be accessible to the applicant through the online permitting system. An authorization under a general permit-by-certification is valid for five years and cannot be extended or modified.

3.1.3 General Permits

General permits are another permit that is issued by rule, as explained in Section 3.1, above. However, unlike permits-by-rule and general permits-by-certification, Department staff must review the proposed activity to ensure that the activity meets the requirements of that general permit, and the Department then issues a written authorization under that permit.

The FHACA Rules include general permits for 13 activities, which are described at N.J.A.C. 7:13-9, and these general permits can be classified into five broad categories – in-stream activities, bridges and roads, buildings, trails and footbridges, and other activities. Appendix C provides a list of the activities eligible for authorization under a general permit organized by category.

The applicant must submit an application for an authorization to conduct the activity under the general permit, but these applications are simpler to prepare and cost less than applications for individual permits. Please note that if an individual permit is required for other activities on the same site, all activities can be reviewed simultaneously under one individual permit application; a separate general permit application is not required.

N.J.A.C. 7:13-18 contains the application requirements for general permits (except for general permit

1, the application requirements for which are at N.J.A.C. 7:13-9.1(d)). The Department also provides application checklists for each type of general permit application on its website at http://www.nj.gov/dep/landuse/forms.html under the Streams/Rivers & Flood Hazard tab.

Public notice is required for all general permit applications (except general permit 1), and the public notice requirements can be found at N.J.A.C. 7:13-19. Each application checklist also explains how to document that public notice was provided. An application fee applies to all general permit applications except general permits 1, 4, and 5. Many general permit applications require a Natural Heritage Letter (see Section 8.4), a verification (see Section 3.2), and/or an engineering certification (see Section 3.3.1).

The Department's review process for general permit applications is explained at N.J.A.C. 7:13-21. An authorization under a general permit is valid for five years and may be extended one time for an additional five years. It may also be modified if necessary.

3.1.4 Individual Permits

Activities with the greatest potential to impact flooding or the environment require a more intensive, case-by-case review and therefore cannot be preapproved under the rules. These activities will require an applicant to submit an application for an individual permit (unless a coastal permit is obtained for the activity, as described in Section 3.1.5).

The requirements for an individual permit depend on the location and nature of the activity. N.J.A.C. 7:13-11 contains the area-specific requirements, which are based on the location of the project. A

project can be located within a particular portion of the regulated area (such as the channel, riparian zone, floodway, or flood fringe) or within an area that contains certain natural resources or special features (such as fishery resources or threatened or endangered species habitat). N.J.A.C. 7:13-12 contains the activity-specific requirements, which apply to particular types of activities, such as the construction of a building or a roadway, regardless of where the activity is located.

Individual permit standards are cumulative. A project may be located in several different regulated areas (floodway, flood fringe, riparian zone, etc.) and involve a number of different activities (roadway, building, utility crossing, etc.). Each relevant section of N.J.A.C. 7:13-11 and N.J.A.C. 7:13-12 must be consulted to determine whether the overall project complies with the design and construction requirements of each section. For example, suppose an applicant proposes to build a single-family home (which does not meet the criteria for a permit-by-rule, a general permit-by-certification, or general permit) on a site that is in a flood fringe and within a 50-foot riparian zone. The home must comply with **all** the following requirements:

N.J.A.C. 7:13-11.2(a) through (e) for a regulated activity in a riparian zone

↓

N.J.A.C. 7:13-11.2(m) for the construction of a single-family home in the riparian zone

↓

The riparian vegetation disturbance limits in Table 11.2 for the construction of a single-family home in the riparian zone

↓

N.J.A.C. 7:13-11.4 for an activity in a flood fringe

↓

N.J.A.C. 7:13-12.1 for all regulated activities

↓

N.J.A.C. 7:13-12.3 for any excavation, fill, and grading

↓

N.J.A.C. 7:13-12.4 for all structures

↓

N.J.A.C. 7:13-12.5 for a building

Additional standards would apply if the home is considered a "major development" under the Department's Stormwater Management Rules at N.J.A.C. 7:8 (see N.J.A.C. 7:13-11.2, Requirements for stormwater management, and Section 14 of this manual) or if the applicant constructs a driveway to the house (see N.J.A.C. 7:13-12.6, requirements for a railroad, roadway, and parking area).

The Department recognizes that situations exist when strict compliance with the individual permit requirements of the FHACA Rules could create excessive difficulty for an applicant. The rules therefore provide for hardship exceptions to individual permits at N.J.A.C. 7:13-15, which allow for any unanticipated, special, and/or unique situations that could arise and that, if not permitted, would cause an exceptional or undue hardship on the applicant.

N.J.A.C. 7:13-18 contains the application requirements for individual permits. The Department also provides application checklists on its website at http://www.nj.gov/dep/landuse/forms.html. Public notice is required for all individual permit applications, and the public notice requirements can be found at N.J.A.C. 7:13-19. Each application checklist also advises applicants how to document that public notice was provided. An application fee applies to all individual permit applications, but that fee varies depending on the project. Information on application fees can be found at N.J.A.C. 7:13-20. Many individual permit applications may also require the following:

- **A verification (see Section 3.2)**
- **An engineering report (see Section 3.3.2)**
- **An environmental report (see Section 3.3.3)**
- **A Natural Heritage Letter (see Section 8.4)**

The Department's review process for individual permit applications is explained at N.J.A.C. 7:13-21. An individual permit is valid for five years and may be extended one time for an additional five years unless the permit is for a linear project of 10 miles or longer or for quarry/mining operations, in which case it is valid for 10 years but cannot be extended. All individual permits may be modified if necessary.

3.1.5 Coastal Permits

If a regulated activity occurs within the jurisdiction of the FHACA Rules and requires a CAFRA or waterfront development permit, the coastal permit should be obtained in lieu of the flood hazard permit, as explained in Section 2.4 of this manual. Under the Coastal Zone Management Rules at N.J.A.C. 7:7, the Department has established special area rules to protect flood hazard areas (N.J.A.C. 7:7-9.25) and riparian zones (N.J.A.C. 7:7-9.26) to ensure that any development in these areas does not adversely impact the area or increase flooding. These special area rules incorporate the construction standards of the FHACA Rules. Therefore, when reviewing a coastal permit application, the Department will determine whether the project meets the requirements of the FHACA Rules for any work proposed within a flood hazard area or riparian zone. As such, obtaining a coastal permit will fully satisfy the design requirements of the FHACA Rules, and there is no need to obtain a separate approval under the FHACA Rules for an activity that has received a CAFRA or waterfront development permit.

However, for a coastal permit to apply to activities regulated under the FHACA Rules, both of the following conditions must be met:

The coastal permit application was declared by the Department as complete for final review on or after November 5, 2007.

If activities are proposed in a fluvial flood hazard area, the applicant meets one of the four conditions at N.J.A.C. 7:13-5.5(a) regarding the need for a verification of the flood hazard area and/or floodway onsite. Therefore, activities authorized under a coastal permit within a tidal flood hazard area do not require a flood hazard verification.

3.1.6 Emergency Authorizations

In some cases, a regulated activity must be conducted immediately to protect the environment and/or public health, safety, or welfare, and the applicant does not have time to first submit an application for an individual permit or an authorization under a general permit. In such cases, the applicant may request an emergency authorization. If the Department issues an emergency authorization, the applicant must still submit an application after the authorization is granted. N.J.A.C. 7:13-16 contains the requirements for issuing an emergency authorization and for the subsequent application.

3.1.7 Combining Permit Types

More than one authorization or permit may be used on a single site. Some examples include, but are not limited to:

- Using a single permit-by-rule repeatedly on one site
- Using a permit-by-rule and an authorization under a general permit on a site
- Conducting more than one regulated activity on a site using a combination of two permits-by-rule and an individual permit

However, the individual limits and conditions of each permit may not be exceeded, either individually or cumulatively. For example, a 400-square-foot building expansion is permitted under permit-by-rule 12, and a 750-square-foot expansion is permitted under general permit-by-certification 5. These two permits cannot be combined to complete a 1,150-square-foot expansion because the overall project exceeds a limit within one or both permits. An individual permit would be required to construct a 1,150-square-foot expansion.

It is also important to note that once the limits of a specific permit are met on a site, no regulated activities can be authorized under that permit, regardless of the amount of time that has passed or whether the site has since been transferred or subdivided.

3.2 Verifications

A *verification* is a document issued by the Department that establishes any or all of the following on a site or any portion of a site:

- **The flood hazard area design flood elevation**
- **The flood hazard area limit**
- **The floodway limit**
- **The riparian zone limit**

The applicant must determine these limits, but the Department will verify whether the limits are accurate.

A verification is useful for determining the extent or limits of the Department's jurisdiction under the FHACA Rules. Also, since the design and construction standards differ for activities inside and outside the flood hazard area, floodway, and riparian zone, knowing the actual limits of these areas is helpful to both the Department and the applicant and is, in many cases, necessary to determine if a proposed activity meets all applicable standards of the FHACA Rules.

An applicant may apply solely for a verification, or the applicant may apply for both a verification and a permit or authorization at the same time. However, it should be noted that a verification is often required as part of an application for an individual permit or a general permit authorization. N.J.A.C. 7:13-5.5 explains when a verification is required. In many cases, the Department cannot evaluate whether a proposed activity meets the design and construction standards without a determination of the limits of the flood hazard area, floodway, and/or riparian zone on a site.

For example, N.J.A.C. 7:13-11.3 prohibits the construction of a building in a floodway in most cases. If a person proposes to construct a building along a stream and the Department does not know where the floodway of that stream is located, the Department cannot evaluate whether the building is proposed within the floodway and therefore cannot determine if the building complies with this standard. Since a verification is needed to establish the floodway limits, the Department cannot issue an individual permit in such a case without a verification.

However, a verification is not required for an authorization under a general permit or an individual permit if one or more of the requirements listed at N.J.A.C. 7:13-5.5(b) is satisfied. The Department must be able to make this determination based on a visual inspection of submitted site plans without a review of calculations. Such determinations are made on a case-by-case basis.

For assistance in determining whether a verification is necessary for a project, call (609) 777-0454 to speak to a Division of Land Use Regulation engineer.

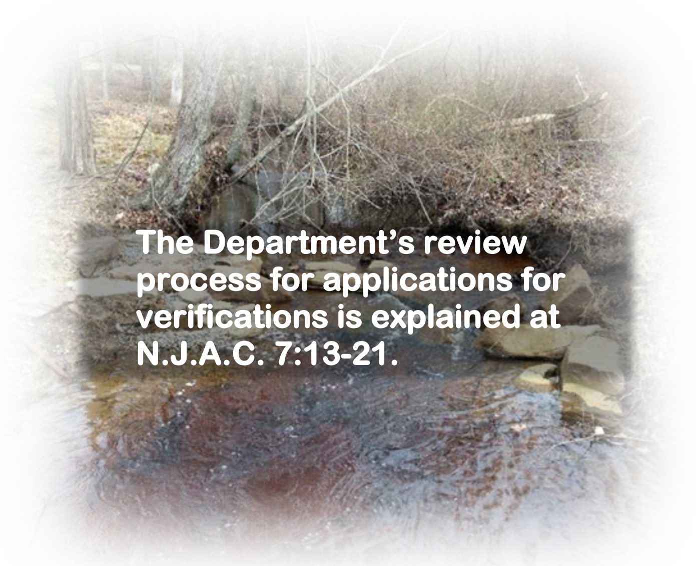
N.J.A.C. 7:13-18 contains the application requirements for verifications. The Department also provides an application checklist on its website at http://www.nj.gov/dep/landuse/forms.html. Public notice is required for applications for verifications of flood hazard area limits based on Methods 4, 5, or 6 (Section 4.4 of this manual contains information on the methods for determining the flood hazard area). The public notice requirements can be found at N.J.A.C. 7:13-19, and each application checklist also advises applicants how to document that public notice was provided. An application fee applies to all applications for verifications, but the fee varies depending on the circumstances. Application fees are listed at N.J.A.C. 7:13-20. Applications for verifications must also include an engineering report (see Section 3.3.2) and a Natural Heritage Letter (see Section 8.4). However, please note that the Natural Heritage Letter is not required if an applicant is only applying for a standalone verification that does not include a riparian zone determination.

Site plans are an essential requirement for any verification application. When verifying the flood hazard area, the plans must include the flood hazard area design flood elevation since this is the basis for drawing the boundaries of the flood hazard area on a site. The elevation must be expressed in feet NGVD or a conversion to NGVD must be provided. NGVD, which is an acronym for the National Geodetic Vertical Datum on 1929, is a universally recognized measurement of elevation above a point roughly equal to sea level. Many site plans today reference the North American Vertical Datum of 1988 (NAVD), which is acceptable provided a conversion to NGVD is provided. FEMA provides information on the relationship between NGVD and NAVD at https://www.fema.gov/media-library-data/20130726-1755-25045-0634/ngvd_navd.pdf. Additionally, NOAA provides an application to convert from one datum to another at https://www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html.

Verifications of a flood hazard area must also include a delineation of the flood hazard area limits on the site unless the entire site lies in a flood hazard area. In such a case, only the flood hazard area design flood elevation will be verified since no flood hazard area boundary actually exists on site. The floodway limits, if they exist onsite, should also be demarcated. The flood hazard area design flood elevation, flood hazard area limits, and/or floodway limits on a site must be established as outlined in N.J.A.C. 7:13-3. Additional guidance regarding the flood hazard area is provided in Section 4 of this manual.

If an application for a verification is submitted with an application for an individual permit or general permit authorization, the verification must show all alterations to the flood hazard area or floodway limit that will be caused by the proposed activities. Grading and/or filling on a site often raises some areas above the flood hazard area design flood elevation and therefore changes the flood hazard area limits. Similarly, bridges, culverts, and other water control structures in a channel can alter the floodway limits. Therefore, verifications must show both the existing (pre-construction) and the proposed (post-construction) flood hazard area and floodway limits.

A verification request must also include the limits of the riparian zone and all supporting documentation utilized to establish the riparian zone, such as the surface water classification of the water adjacent to and downstream of the site (see the Surface Water Quality Standards at N.J.A.C. 7:9B). The appropriate riparian zone width onsite can be determined as described at N.J.A.C. 7:13-4.1. Section 6 of this manual provides more information regarding riparian zones, including riparian zone widths.



The Department's review process for applications for verifications is explained at N.J.A.C. 7:13-21. Within 90 calendar days after receiving a verification, the applicant must record the verified flood hazard area and/or floodway limits on the deed for the property by submitting the information listed at N.J.A.C. 7:13-5.6(a) to the Office of the County Clerk or registrar of deeds and mortgages in each county in which the site is located. This will ensure that future buyers of the property will be aware that the site may be subject to flooding under various circumstances and will disclose the location of any flood hazard area and/or floodways onsite. The recipient of the verification must provide proof, consisting of a copy of the complete recorded document, a receipt from the clerk, or other proof provided by the recording office, to the Department that the verification has been recorded. A copy of the complete recorded document must be provided to the Department within 180 days of issuance or reissuance of a verification if not provided as initial proof.

Most verifications are issued for five years and may be extended one time for an additional five years. A verification may automatically be reissued in some cases. If an individual permit or general permit authorization that references or relies upon the verification is issued for the same site, a valid verification is automatically reissued. Automatically reissued verifications may not be extended. For linear projects of 10 miles or longer and for quarry/mining operations, an individual permit and its associated verification can be issued for ten years. Verifications may be modified if necessary. If the Department determines that a verification was based on false or inaccurate information, the verification will be suspended.

3.3 Application Requirements

While the FHACA Rules establish application requirements for permits, authorizations, and verifications, application checklists (available at http://www.nj.gov/dep/landuse/forms.html) provide more detailed requirements for each generic application requirement. For example, the rules may require "other visual representations, such as photographs, graphs, and tables, which illustrate existing site conditions and the proposed delineation, activity, or project." However, the checklist for general permit 2 (mosquito control activities) specifies how an applicant should satisfy that requirement by requesting color photographs showing the entire project area, the location of cross-sections of ditches and channels depicted on the site plans, and all access points to the activities. The checklist also specifies that photographs must be mounted on 8 ½-inch by 11-inch paper and accompanied by a map showing the location and direction from which each photograph was taken.

Common application checklist items include:

- **An application form (found at http://www.nj.gov/dep/landuse/forms.html)**
- **An application fee (see N.J.A.C. 7:13-20)**
- **Public notice (see N.J.A.C. 7:13-19)**
- **A Natural Heritage Letter for threatened and endangered species (see Section 8.4)**
- **A verification (see Section 3.2)**
- **An engineering certification (see Section 3.3.1)**
- **An engineering report (see Section 3.3.2)**
- **An environmental report (see Section 3.3.3)**

Sections 3.4.1 through 3.4.3 below provide general guidance to aid in the preparation of an engineering certification, engineering report, and environmental report. However, Sections 4 through 14 of this manual provide more detailed information, such as how to perform and report calculations and how to prepare drawings or site plans, for specific activities (e.g., buildings and bridges) and for activities in specific areas (e.g. flood hazard areas and riparian zones).

Please note that, under N.J.A.C. 7:13-18.2(j), any professional report, survey, calculation, environmental impact statement, or other document prepared by a consultant, engineer, land surveyor, architect, attorney, scientist, or other professional and submitted as part of an application must include the following certification:

> **"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining and preparing the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for knowingly submitting false information, including the possibility of fine and imprisonment."**

3.3.1 Engineering Certification

Several applications for authorizations under general permits and general permits-by-certification require an engineering certification to confirm that the activity meets certain permit requirements, such as flood storage displacement requirements (see Section 5). An engineering certification is additionally required to obtain an individual permit in a number of cases depending on the particular project elements being proposed.

The engineering certification must be signed and sealed by a New Jersey licensed professional engineer and include all supporting documentation, calculations, and other information upon which the certification is based. A New Jersey licensed professional engineer employed by the Department may reject an engineering certification if there is clear and compelling evidence of a threat to public health, safety, or welfare or the environment if the project is approved as designed.

3.3.2 Engineering Report

Any flood hazard area verification based on Methods 4, 5, or 6 (see Section 4.4 of this manual for more information on these methods) or individual permit application requires an engineering report prepared as described at N.J.A.C. 7:13-18.5. The purpose of the engineering report is to provide the Department's engineers with information necessary to evaluate whether any proposed flood hazard area design flood elevation, flood hazard area or floodway limit, or structure within a flood hazard area meets the requirements of the FHACA Rules. Appendix D of this manual provides an example outline for an engineering report for an individual permit, and Appendix E provides an example outline for an engineering report for a verification.

The engineering report should be a bound document beginning with a clear description of all elements of the project regulated under the FHACA Rules and a summary table demonstrating compliance with each applicable standard. For example, if an applicant proposes to place fill within the flood fringe outside of the Central Passaic Basin, the summary table should identify the flood fringe storage volume available on January 31, 1980, the proposed fill volume, and the proposed compensation volume. Following the summary table, the engineering report should contain the actual calculations demonstrating compliance with the FHACA Rules with appropriate references to any accompanying engineering drawings.

Design and construction standards for individual permits are found at N.J.A.C. 7:13-11 and 12 in the FHACA Rules. As previously noted, these subchapters itemize the specific requirements for the entire range of activities regulated by the rules. The engineering report needs to refer to each specific section of the rules relevant to the project. The contents of the report should be structured as a response to each of the design requirements for a given section of the subchapter. When no calculations are required in a particular case, the format of the report should be an itemized, point-by-point response to each design standard. Where calculations are required, a more detailed report containing specific information must be submitted as follows:

1. **Hydrology and Hydraulics** – Hydrologic and hydraulic calculations are typically required when a flood hazard area verification is requested or when in-watercourse activities are proposed, such as bridges, culverts, dams, stream stabilization and restoration projects, and flood control projects. Section 4 explains how to perform and report such calculations. In particular, see Section 4.8, Engineering Report Requirements for Hydrology and Hydraulics.

2. **Net fill** – In many cases, a geometric computation of the change in flood storage volume on a site must be provided to the Department to demonstrate compliance with the net-fill requirements of N.J.A.C. 7:13-11.4, as discussed in Section 5 of this manual. Section 5.5 specifically explains how to report net fill calculations to the Department.

3. **Stormwater Management** – A stormwater management report must be submitted for any project that qualifies as a major development, as defined by the Stormwater Management Rules at N.J.A.C. 7:8-1.2, which is explained in Section 14 of this manual. This report must demonstrate compliance with both the FHACA Rules at N.J.A.C. 7:13-11.2 and the Stormwater Management Rules at N.J.A.C. 7:8. Section 14.4 describes the requirements for this report.

4. **<u>Stability Analysis</u> -** An engineering certification is required for retaining walls and bulkheads four feet or greater in height that are located within a regulated water, a floodway, or within 25 feet of any top of bank (see N.J.A.C. 7:13-12.13). The certification must confirm that the retaining wall or bulkhead is designed with stable footings and is designed to withstand displacement, overturning, and failure due to undermining and/or pressure from soil, water, and frost. Additionally, if the retaining wall or bulkhead is located within a regulated water or within 25 feet of any top of bank, it must be designed to be resistant to erosion as well as the possibility of a shifting bed and/or bank over time. Since engineering certifications must be accompanied by all supporting documentation, calculations, and other information upon which the certification is based, the certification should include a descriptive summary of the design specifications that explain how the proposed design will resist uplift and overturning during a flood event equivalent to the regulatory flood as well as a copy of the actual calculations.

3.3.3 Environmental Report

An environmental report must be submitted for all individual permit applications and must include **all** of the following components, as described at N.J.A.C. 7:13-18.6(a)1-3:

1. A written narrative describing the proposed design and the construction techniques that will be employed to help Department staff understand what is being proposed, the decisions that led to the chosen design, and how the project will be implemented so their application reviews are more efficient

2. Maps providing an environmental inventory of the site, such as freshwater wetlands maps and USDA soil surveys, to assist Department staff in better understanding site conditions and environmental resources of the area

3. An analysis focusing on any potential adverse environmental impacts the project is likely to cause and describing how these potential impacts will be minimized

This analysis should discuss all potential temporary and permanent adverse impacts, both onsite and offsite, associated with each proposed activity to channels, riparian zones, fishery resources, threatened or endangered species and their habitat, and regulated waters, including whether the proposed construction will potentially cause erosion and turbidity. To analyze the potential environmental impacts, the environmental report must include all of the following materials:

1	A justification for the purpose and need for the project, including an explanation of why any proposed regulated activity or project and its location is the most appropriate for the site and how the proposed location and design minimizes adverse environmental impact(s) to the identified resources
2	An analysis of alternatives to the proposed project, including the no-build alternative, which describes how the proposed design avoids or minimizes environmental impacts, onsite and offsite, compared to alternative project designs
3	A description of all measures to be taken to reduce temporary and permanent detrimental impacts to each resource, whether onsite or offsite, such as soil erosion and sediment control measures that will be implemented and construction techniques that minimize adverse impacts to environmental resources
4	A plan to mitigate the effects of any adverse impacts to each resource, whether onsite or offsite

An example project is provided below. See Appendix F of this manual for an example outline of an environmental report.

EXAMPLE:

An applicant proposes to construct a new private roadway across a trout production water with a 150-foot riparian zone to access an upland lot for residential development. Disturbance to the riparian zone is limited to the roadway (which includes a sidewalk along both sides), a stormwater discharge from a proposed detention basin that is located outside the riparian zone, and a guard booth. (See Section 6 for riparian zones, Section 10 for bridges and culverts, and Section 14 for stormwater management.)

The environmental report for this example should at a minimum provide the following information:

1. A description of all proposed impacts to the regulated water and its riparian zone, including the area and type of vegetation proposed to be impacted. This is often best shown in a table such as the following:

	Road crossing	Stormwater discharge		Guard booth	
		Headwall & outlet protection	Stormwater pipe	Total	Non-actively disturbed
Maximum disturbance to RZ vegetation under Table 11.2	12,000 ft^2	2,000 ft^2	3,000 ft^2	10,890 ft^2 (one-quarter of an acre)	3,000 ft^2
Proposed disturbance to RZ vegetation	15,000 ft^2	1,250 ft^2	3,500 ft^2	4,000 ft^2	750 ft^2
Actively disturbed areas	7,000 ft^2	0 ft^2	2,000 ft^2	4,000 ft^2	n/a
Forested areas	3,000 ft^2	0 ft^2	500 ft^2	n/a	300 ft^2
Other disturbance	5,000 ft^2	1,250 ft^2	1,000 ft^2	n/a	450 ft^2
Subsection that is being met	(h)	(j)	(j)	(y)	(y)
Proposed mitigation	3,000 ft^2	0 ft^2	500 ft^2	4,000 ft^2	

2. A description of how all potential riparian zone disturbances have been avoided wherever possible. This should include a discussion of whether there is another means of accessing the upland areas without crossing the regulated water (and if so, why it wasn't suitable for this site) and whether the stormwater discharge and guard booth could practicably be located outside the riparian zone. Include information about relevant land use restrictions and requirements that might prevent the use of some alternatives. For example, the applicant could explain that the stormwater discharge must be located within the riparian zone to meet the offsite stability requirements of the local soil conservation district.

3. A description of how all proposed impacts have been minimized. Include design alternatives that were found to be impractical. For example, the applicant could explain that the guard booth must be a certain size to safely house an individual along with necessary safety equipment. Another example is a discussion on whether the roadway width has been minimized. The applicant should explain whether the construction of a sidewalk along both sides of the roadway is necessary to meet the Residential Site Improvement Standards or another local requirement and whether it is safe and practicable to have either one or no sidewalks along the roadway. The applicant should also discuss how the roadway alignment was determined and whether alternative crossing locations would reduce disturbance to riparian zone vegetation and the channel and whether side slopes along the roadway have been minimized to reduce the width of disturbance.

4. A description of how work was located within actively disturbed areas to the maximum extent practicable. For example, the applicant could explain that the road crossing largely avoids

forested areas and mainly impacts actively disturbed areas and areas of scrub/shrub, etc. and that moving the roadway more fully into actively disturbed areas would unacceptably increase freshwater wetlands impacts.

5. A description of how the proposed roadway crossing minimizes impacts to aquatic species, whether the work will be done during restricted periods of time (such as when trout are spawning), whether any threatened or endangered species will be impacted, whether the crossing completely spans the channel as is generally required under the FHACA Rules, and whether terrestrial wildlife crossings are warranted at this site.

6. Since this example project requires mitigation, a description of the proposed mitigation plan, including the total area of riparian zone mitigation needed (7,500 square feet in this example), the method or methods that will be used to provide mitigation, the location of the mitigation, and a demonstration that the mitigation requirements of N.J.A.C. 7:13-13 are met. **Note that a mitigation plan can be submitted with an application for an individual permit or can be provided after the individual permit is approved, provided the conditions of the permit are met.** See Section 7 of this manual for more information on mitigation.

If a project is likely to disturb an area known to contain a threatened or endangered species or an area containing habitat that could support such a species, the environmental report must include a survey and/or habitat assessment for threatened or endangered species. Section 8 of this manual contains more information on threatened or endangered species. See Section 8.4 for a discussion of the survey and/or habitat assessment requirement.

3.4 Conditions

All permits and authorizations approved under the FHACA Rules are subject to certain conditions. Even if an applicable condition is not specifically listed in the permit or authorization, it still applies to the project. For example, written authorization from the Department is not necessary to undertake an activity under a permit-by-rule, but all conditions relevant to that permit-by-rule must be observed or the applicant will be in violation of the FHACA Rules.

Types of conditions include:

- General conditions that apply to all permits
- Permit-specific conditions
- Project-specific conditions
- Conditions that depend on the type of permit or authorization

General Conditions That Apply to All Permits

All authorizations and permits are subject to the 14 conditions found at N.J.A.C. 7:13-22.2(c). These general conditions include such requirements as obtaining all other applicable Federal, State, and local approvals before beginning the activity and informing the Department immediately if any adverse impact to the environment results from the permitted activity.

Permit-Specific Conditions

All authorizations and permits are subject to permit-specific conditions. For permits-by-rule, general permits-by-certification, and general permits, these permit-specific conditions are located in the FHACA Rules at N.J.A.C. 7:13-7, 8, and 9, respectively, and they limit the scope of work that may fall under a particular permit. For example, the construction of a fence would qualify for permit-by-rule 20, provided the proposed fence met the three distinct requirements for that permit-by-rule at N.J.A.C. 7:13-7.20. One of these requirements is that the fence cannot be located within 25 feet of any top of bank or edge of water unless it is adjacent to a lawfully existing bulkhead, retaining wall, or revetment along a tidal water or impounded fluvial water. If the proposed fence is to be located 15 feet from the top of bank of a regulated tidal water with an undefended shoreline, it would not qualify for the permit-by-rule. Construction of such a fence without a general permit, general permit-by-certification, individual permit, or coastal permit would, therefore, be a violation of the FHACA Rules.

For individual permits, permit-specific conditions depend on the nature and location of the activity and are found at N.J.A.C. 7:13-11 and 12, as explained in Section 3.1.4. All applicable permit-specific conditions will be included in the individual permit approval issued by the Department.

Project-Specific Conditions

Project-specific conditions may apply to any activity authorized under a general permit or an individual permit. These are special conditions that the Department may include at its discretion to ensure full compliance with the FHACA Rules. For example, if a proposed activity involves disturbance to a Category One water or its riparian zone, the Department may insert additional conditions into the permit to ensure that water quality will not be impacted by the activity. If this determination is made, the special conditions will be included in the issued general permit authorization or individual permit.

Conditions That Depend on the Type of Permit or Authorization

Additional conditions are applicable depending on the type of permit or authorization that has been approved. The five conditions listed at N.J.A.C. 7:13-6.7(b) apply to all permits and authorizations except individual permits while the 13 conditions listed at N.J.A.C. 7:13-22.2(d) apply to all permits except permits-by-rule. One important condition to note is that all permits except permits-by-rule and an authorization under general permit 1 for channel cleaning under the Stream Cleaning Act at

N.J.A.C. 7:13-9.1 must be filed with the Office of the County Clerk (the Registrar of Deeds and Mortgages, if applicable) of each county in which the site is located. The permit must be recorded within 30 calendar days after the applicant receives it unless the permit authorizes activities within two or more counties, in which case it must be recorded within 90 calendar days of receipt. After the permit has been recorded, a copy of the recorded permit must be forwarded to the Division of Land Use Regulation.

3.5 Inspections

Department staff has the right to inspect a site regardless of whether a permit or authorization has been issued for that site. N.J.S.A. 13:1D-9 provides the Department with the power to enter and inspect any property, facility, building, premises, site, or place to investigate actual or suspected pollution of the environment and assess compliance or noncompliance with any laws, permits, orders, codes, rules, and regulations of the Department. On the application form for a general permit-by-certification or general permit authorization, an individual permit, or a verification, applicants must consent to allowing Department staff to access the site.

Additionally, a permittee must allow inspections of the site and the activity as a condition of any permit issued under the FHACA Rules (see the conditions that apply to all permits at N.J.A.C. 7:13-22.2(c)). If a Department staff member shows their credentials "at reasonable times" (i.e., during normal business hours or other hours in which the regulated activity is occurring or the project is under construction), the permittee must allow the staff member to enter the site where the regulated activity or project is occurring or where any records required by the permit are kept. Refusing to allow Department staff to perform inspections is considered a violation of the permit.

SECTION 4
FLOOD HAZARD AREAS

N.J.A.C. 7:13-1.2 defines the *flood hazard area* as the land, and the space above that land, that lies below the *flood hazard area design flood elevation*. In New Jersey, this elevation is based on the 100-year flood with an added factor of safety in fluvial (non-tidal) areas to ensure that residents are protected and structures are built safely. The 100-year flood is explained in Section 4.1 of this manual while Section 4.3 describes the differences between fluvial and tidal flood hazard areas.

Structures, fill, and vegetation that are situated on land that lies below the flood hazard area design flood elevation are considered to be within the flood hazard area. The inner portion of the flood hazard area is called the *floodway*, and the outer portion of the flood hazard area is called the *flood fringe*. Section 4.2 provides more information on distinguishing the floodway and flood fringe.

Knowing the flood hazard area design flood elevation and floodway limits is, in many cases, necessary to demonstrate that a proposed activity complies with the requirements of the FHACA Rules at N.J.A.C. 7:13. Many of the standards in these rules are designed to ensure that buildings, roads, and other structures will not be flooded, damaged by flooding, or cause additional flooding, and that flood storage is not being excessively displaced by a given activity. Demonstrating compliance with these and other standards in the rules requires knowledge of the depth of flooding at a given site and the location of the floodway. For example, proving that the lowest habitable floor of a proposed new building is situated above the design flood elevation, as required by N.J.A.C. 7:13-12.5, is impossible if the design flood elevation is unknown at that location. For this reason, and in most cases, the Department requires a verification of the flood hazard area and/or floodway limits on a site. See Section 3.2 of this manual for more information regarding verifications.

Flood Hazard Area:
The land, and the space above that land, that lies below the flood hazard area design flood elevation.

A flood hazard area only exists along a watercourse that has a drainage area (watershed size) of at least 50 acres. Watercourses that have a drainage area of less than 50 acres do not possess regulatory flood hazard areas of their own. However, these watercourses may be located in the flood hazard areas of larger regulated waters.

Section 4.4 explains the six methods for determining the limits of a flood hazard area. To do so, it may be necessary to calculate peak flow rates and hydrographs, as discussed in Section 4.5, and flood elevations, as discussed in Section 4.6. Section 4.7 explains how to calculate floodway limits. Finally, Section 4.8 provides guidance on what to submit as part of any application to establish the location and characteristics of a flood hazard area.

4.1 Flood Frequency and Risk

A flood hazard area is primarily based on the 100-year flood. The 100-year flood is not a flood that will occur only once every 100 years, as the name might imply. Instead, it reflects the average recurrence interval (i.e., 100 years) that a flood of this magnitude is expected to occur or be exceeded over an extended period of time, which is much longer than 100 years in some cases. Statistical analysis of flood records indicates that floods of a given magnitude actually occur randomly over that time period. Therefore, the 100-year flood will not follow such a regular schedule and occur once every century. In fact, a 100-year flood could occur or be exceeded along a particular watercourse several times in successive years or even within the same year. Conversely, such a flood may not occur or be exceeded for hundreds of years. Similar logic applies to other floods referenced by average occurrence intervals, such as the 10-year, 25-year, or 500-year flood.

In addition to demonstrating that floods are statistically random events, flood records also indicate that the magnitude of a specific flood is directly related to the length of its average recurrence interval (with smaller floods occurring more frequently than larger ones). Thus, the magnitude and severity of a specific flood can alternatively be described in terms of its chance, probability, or **risk** of occurring or being exceeded in a given year. Therefore, instead of expressing how many times on average a specific flood may occur over an extended period, which can be misleading, expressing that flood's chance of occurring in a given year more clearly communicates both the randomness of flooding and the risk or threat level posed by that specific flood. For this reason, the Federal Emergency Management Agency (FEMA), which is responsible for delineating flood plains for the federal flood insurance program, now utilizes the annual risk method of flood designation. However, the FHACA Rules continue to refer to flood events by the average recurrence interval.

Converting a flood's average recurrence interval to its annual risk (and vice versa) is a straightforward calculation:

Annual Flood Risk (in Percent) = 100 / Average Recurrence Interval (in Years)

Average Recurrence (in Years) = 100 / Annual Flood Risk (in Percent)

Therefore, a flood with a 5-year average recurrence interval will have an annual flood risk of:

100 / 5 Years = 20 Percent

A flood with a 50 percent annual risk will have an average recurrence interval of:

100 / 50 Percent = 2 Years

Figure 4.1 provides a summary of various average recurrence interval floods and their related annual flood risks.

Figure 4.1: Average Flood Recurrence Intervals and Associated Annual Flood Risks

Average Recurrence Interval	Annual Risk
1-Year	100 Percent
2-Year	50 Percent
5-Year	20 Percent
10-Year	10 Percent
25-Year	4 Percent
50-Year	2 Percent
100-Year	1 Percent
500-Year	0.2 Percent

Whether a flood is described by its average recurrence interval or by its annual risk, both express the flood's chances of being equaled **or exceeded**. As such, the 100-year flood has a 1 percent chance of occurring in a given year or being exceeded in that year.

4.2 The Floodway and the Flood Fringe

As previously mentioned, the flood hazard area consists of a floodway and a flood fringe. As defined in N.J.A.C. 7:13-1.2, the floodway is the inner portion of the flood hazard area that is mathematically determined to be required to carry and discharge floodwaters resulting from the 100-year flood under certain conditions (see Section 4.7 for information on how to calculate the floodway limits). The floodway always includes the channel but also generally includes land adjacent to the channel. Since the depth and velocity of flooding in the floodway is typically greater than within the flood fringe, development in a floodway is subject to greater flood damage potential. Development within a floodway can also create a significant obstruction to flow, which further increases the depth of flooding and flood damage, exacerbates watercourse instability, and adversely impacts nearby properties, water quality, and fishery resources and other aquatic biota.

The flood fringe is the portion of the flood hazard area that lies outside the floodway. While the purpose of the floodway is to convey floodwaters, floodwaters generally move more slowly in the flood fringe. As such, the main function of the flood fringe is to temporarily store floodwaters during a flood. The space that floodwaters occupy on a given site within the flood fringe during a flood is referred to as the *flood storage volume* of that site. Development is generally allowed in the flood fringe, but strict standards still apply because unchecked development can lead to a loss of flood storage volume, which can increase the depth and velocity of flooding, leading to increased flooding, public safety hazards, and loss of property. See Section 5 for a discussion of the flood storage displacement standards under the FHACA Rules.

Figures 4.2, 4.3, and 4.4 show the two components of a typical flood hazard area (the floodway and flood fringe) from three points of view. Figure 4.2 below provides a three-dimensional view of a watercourse flowing near a house located within the flood fringe. This view provides a sense of the extent of the flood hazard area as it relates to its surroundings.

Figure 4.2: The Flood Hazard Area

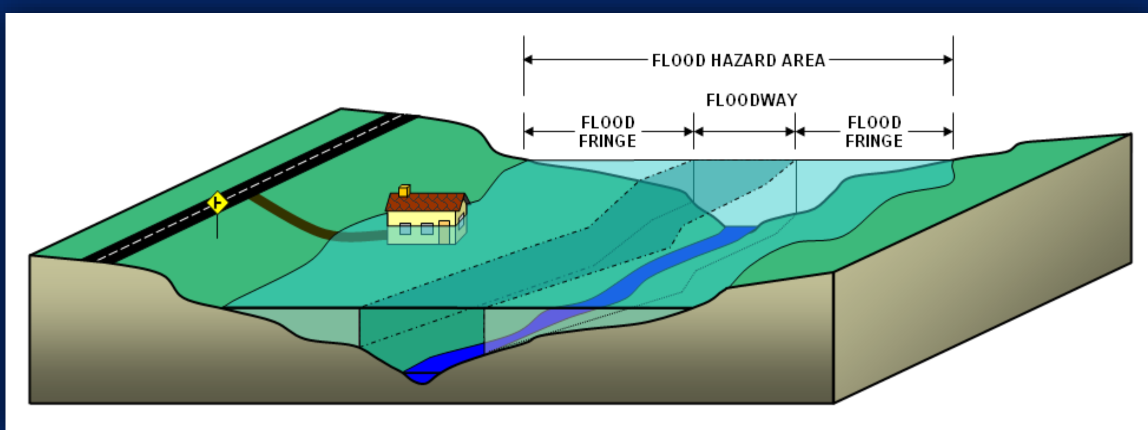


Figure 4.3 on the next page shows a cross-section view of the same regulated water and flood hazard area as shown in Figure 4.2. This view clearly illustrates the demarcation between the two components of the flood hazard area.

Finally, Figure 4.4 (also on the next page) shows a plan view of the same area. Notice that the flood hazard area limit (the outer edge of the flood fringe) curves as it follows the contours of the ground while the floodway limit, which is mathematically determined at various points along the stream, is defined by straight line segments.

Figure 4.3: The Flood Hazard Area in Cross-Sectional View

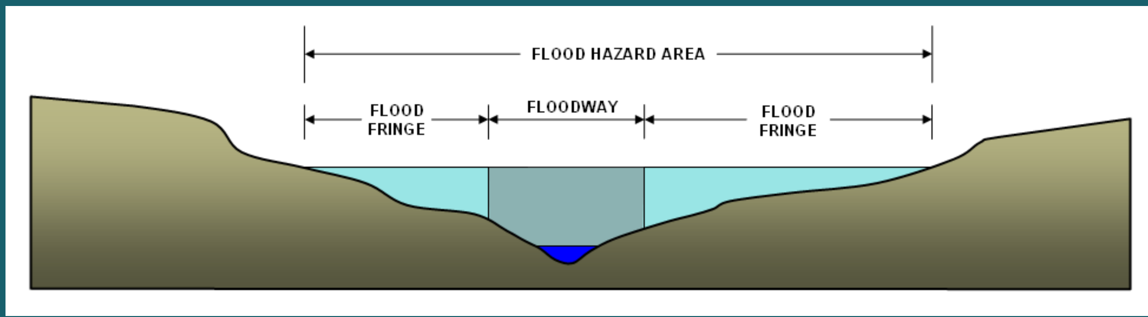
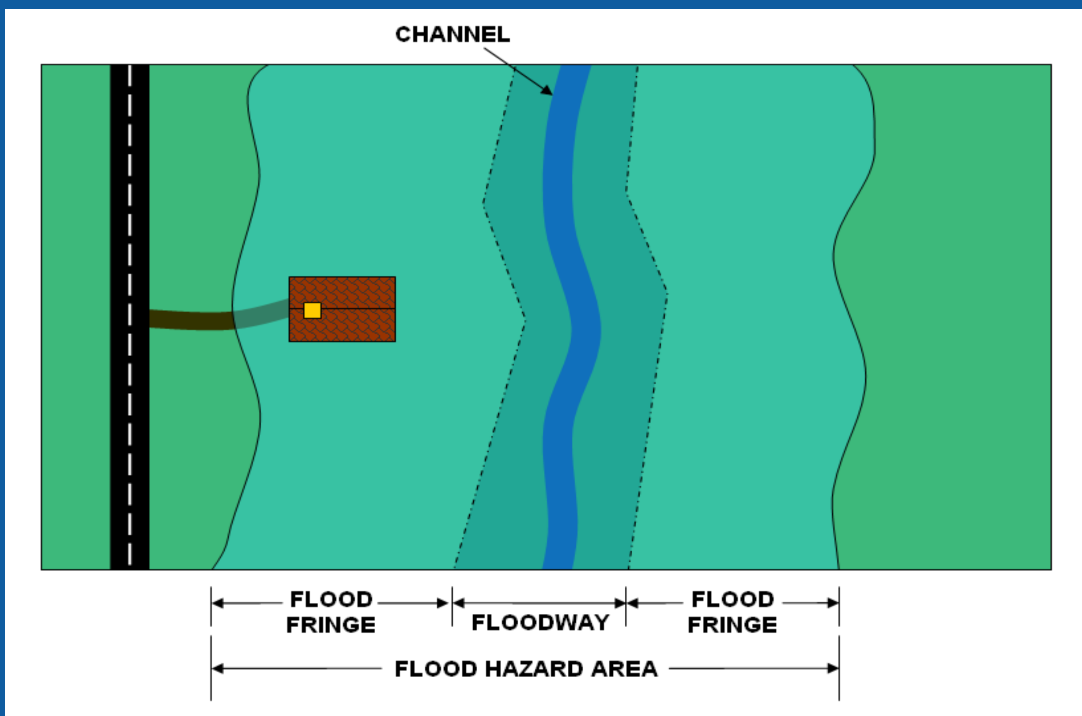


Figure 4.4: The Flood Hazard Area in Plan View



4.3 Tidal vs. Fluvial Flood Hazard Areas

N.J.A.C. 7:13-1.2 specifies two types of flood hazard areas:

Tidal

- **Areas where the flood hazard area design flood elevation is governed by tidal flooding from the Atlantic Ocean**

Flooding in a tidal flood hazard area may be influenced by stormwater runoff from inland areas, but the depth of flooding generated by the Atlantic Ocean is greater than the depth of flooding generated by any fluvial sources for the same average recurrence interval or annual flood risk (see Section 4.1 for a discussion of flood frequency and risk).

Fluvial

- **Areas where the flood hazard area design flood elevation is governed by stormwater runoff**

Flooding in a fluvial flood hazard area may be influenced by elevated water levels generated by the tidal rise and fall of the Atlantic Ocean, but the depth of flooding generated by stormwater runoff is greater than the depth flooding generated by the Atlantic Ocean.

Other rules or regulations may refer to a watercourse as either tidal or fluvial (non-tidal), but the meaning may be different. Note that for the purposes of N.J.A.C. 7:13, the terms “tidal” and “non-tidal” refer to a controlling flood event, not to the ebb and flow of the daily tidal cycle. While many watercourses are subject to the daily tidal cycle and have a tidally controlled flood event, many others may be subject to the daily tidal cycle but have a fluvially controlled flood hazard area, such as portions of the Passaic River. Conversely, other watercourses are not subject to the daily tidal cycle but have tidally-controlled flood hazard areas.

The FHACA Rules distinguish between tidal flood hazard areas and fluvial flood hazard areas in this way because different regulatory standards apply based on the controlling flood event. As such, care must be taken in determining which type of flood governs. For example, many watercourses in and near coastal areas are tributaries to larger waters that have tidally controlled flood hazard areas. A published flood map (see Section 4.4) may show that the tidal flood hazard area of the larger watercourse encompasses a portion of the tributary, but the corresponding flood study may not have analyzed this tributary, which means that the flood hazard area of the tributary is unknown and is not necessarily a tidal flood hazard area.

Should this tributary have a contributory drainage area of at least 50 acres, it has its own regulated flood hazard area. When this is the case, the fluvial flood elevation of the tributary must be analyzed. If the computed fluvial flood hazard area design flood elevation of this tributary is higher than that of the larger water, the tributary has a fluvial flood hazard area despite being located in the mapped tidal flood hazard area of the larger water.

It is also important to note that some watercourses may be under fluvial control during smaller flood events but under tidal control during larger events (or vice versa). As such, the same watercourse may be regulated as both a tidal water and a fluvial water, depending on the flood event that must be considered for the application of each regulatory standard.

4.4 Establishing the Flood Hazard Area Limits

As mentioned previously, the flood hazard area limits are determined from the flood hazard area design flood elevation. Land that lies below the flood hazard area design flood elevation is within the flood hazard area while land situated at elevations higher than the flood hazard area design flood elevation is outside of the flood hazard area.

N.J.A.C. 7:13-3 presents six methods for determining the flood hazard area design flood elevation along a regulated water:

- **Method 1: The Department Delineation Method** — Section 4.4.1
- **Method 2: The FEMA Tidal Method** — Section 4.4.2
- **Method 3: The FEMA Fluvial Method** — Section 4.4.2
- **Method 4: The FEMA Hydraulic Method** — Section 4.4.2
- **Method 5: The Approximation Method** — Section 4.4.3
- **Method 6: The Calculation Method** — Section 4.4.4

Each method has certain inherent restrictions on its use, as discussed in detail in Sections 4.4.1 through 4.4.4 below. Therefore, while the FHACA Rules provide six different methods for determining the flood hazard area, fewer than six methods will typically be available or acceptable for use for a given water, site, or project, and in some cases, only one method may be available or acceptable. Not all methods will provide the type of information or the level of detail necessary to issue a permit for certain activities on a site. If an applicant has a particular project in mind, the permitting requirements for that project may govern which delineation method is selected.

For example, consider the proposed construction of a single-family dwelling. Since the construction of a new dwelling in a floodway is prohibited under N.J.A.C. 7:13-11.3, the applicant must prove to the Department that it will be located outside the floodway. To be able to demonstrate this, the applicant will need to choose a delineation method that provides a floodway limit. As such, the applicant cannot utilize Method 5 because this method does not determine the floodway limits. Then, upon review of the available information, the applicant may find that there is no Department delineation or FEMA delineations for the area in question. Therefore, Methods 1 through 4 cannot be used either. By process of elimination, the only method available to identify the relevant flood information for this project is Method 6.

4.4.1 Method 1: Department Delineation Method

In many cases, the Department has promulgated (meaning adopted into regulation) flood mapping that indicates the flood hazard area design flood elevation and floodway limits along various waters. Such mapping is more commonly referred to as a Department delineation or a State study. More than 2,500 miles of regulated waters have been delineated by the Department in this way. A list of these waters is provided in Appendix 2 of the FHACA Rules. This appendix lists each promulgated water alphabetically by county and municipality and describes the limits of every promulgated study along each water where such studies exist.

To obtain a copy of a Department delineation, including flood profiles and maps, or for assistance regarding the use, derivation, or modification of these delineations, contact the Department's Office of Flood Plain Management at:

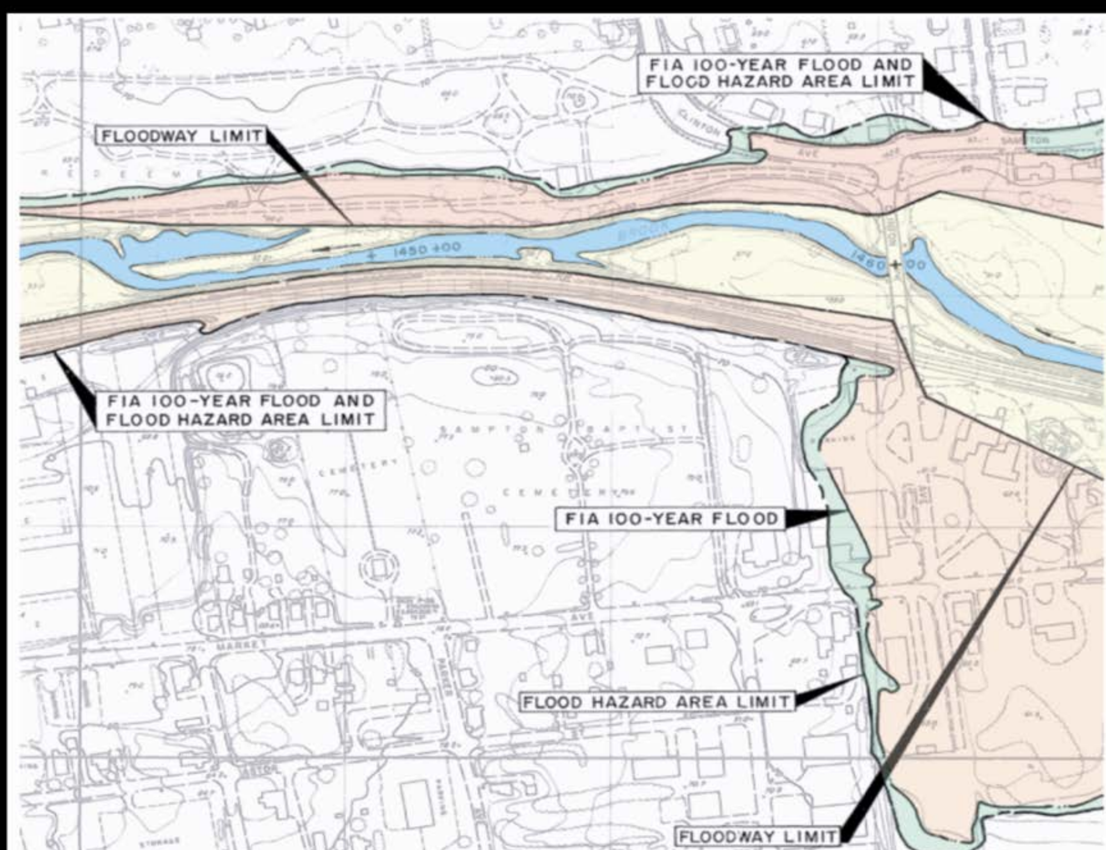
STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF DAM SAFETY AND FLOOD CONTROL
P.O. BOX 419
TRENTON, NEW JERSEY 08625-0419
TELEPHONE: (609) 984-0859

As required under N.J.A.C. 7:13-3.2(b), if a Department delineation promulgated on or after January 24, 2013 exists for a given water, the Department delineation must be used for all applications. An applicant cannot use another delineation method to determine the flood hazard area or floodway limits.

However, if a Department delineation exists for a given water but it was promulgated prior to January 24, 2013, the Department delineation may be used as described in N.J.A.C. 7:13-3.2(c) but only if it shows more conservative flood information (i.e., a higher flood hazard area design flood elevation or wider floodway limit) than do any of the FEMA methods. Because the most conservative flood information is required, in some instances, information from a Department delineation may need to be combined with information from a FEMA map to determine the regulatory flood elevation and floodway limits (see the discussion of combining maps in Section 4.4.2). Alternatively, Method 6 can be used (see Section 4.4.4).

Under Method 1, the floodway limit is shown on the flood maps adopted as part of the Department delineation, as shown in Figure 4.5 (which has been colorized to help illustrate the various portions of the flood hazard area). The floodway limits are exactly as shown on this map and should be scaled directly off the map onto site plans.

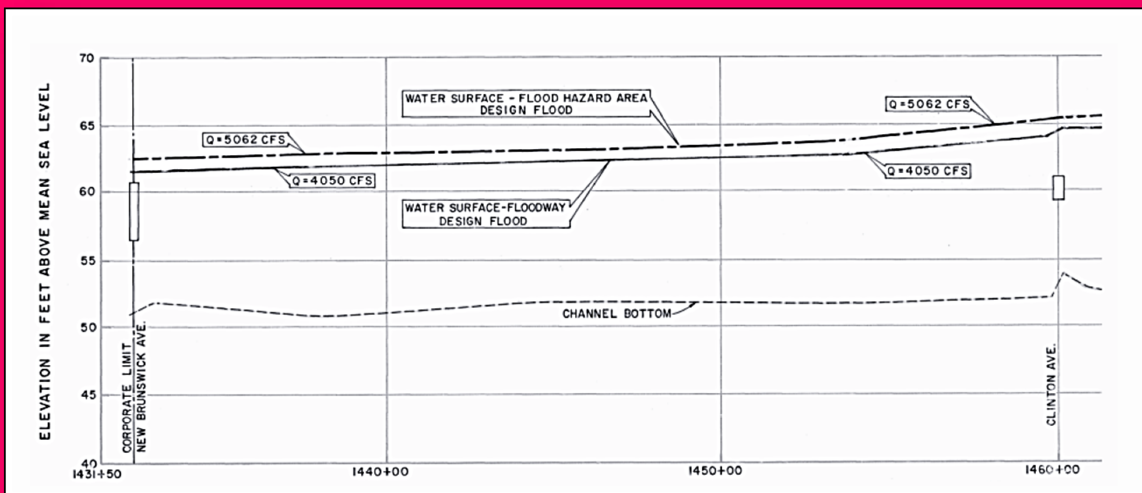
Figure 4.5: Plan View of a Department Delineation



However, the flood hazard area design flood elevation is that shown on the flood profile adopted as part of the Department delineation, not the flood map. The flood hazard area and 100-year flood limits on the flood maps are only approximate representations based on the topography available at the time of mapping. Therefore, even if the mapping shows an area to be within (or outside of) the flood hazard area, **the actual extent of flooding on a site must be determined based on the ground elevation as compared with the flood hazard area design flood elevation.**

An example of a flood profile that typically accompanies a flood map is shown in Figure 4.6 below. A profile view can be used to determine the exact design flood elevation at a given point. This elevation can then be compared with ground elevations to determine the extent of the flood hazard area on a given site.

Figure 4.6: Profile View of a Department Delineation



Since profile views depict continuous flood elevations along a waterway, they are usually the most accurate and reliable way of determining the flood elevations along a delineated waterway, including those delineated by the Department, which is why Department and most other delineations include both plan and profile views of the flood limits and levels along a delineated waterway. An applicant cannot rely solely on the plan view, as illustrated by Figures 4.7 and 4.8.

Figure 4.7 on the following page shows the same plan view as Figure 4.5 but with a specific area circled in red. For this area, the 100-year flood plain is depicted as equivalent to the flood hazard area. However, when the profile view is examined for this area (see Figure 4.8 on the next page), the flood hazard area design flood elevation is one foot higher than the 100-year elevation.

This apparent discrepancy is due to both the scale of the plan view and the steep topography in the general vicinity. If only the plan view were to be used, the flood hazard elevation is inaccurate, an error that can lead to a project that fails to comply with the standards of the FHACA Rules and denial of a permit.

Figure 4.7: Limitations of Plan View

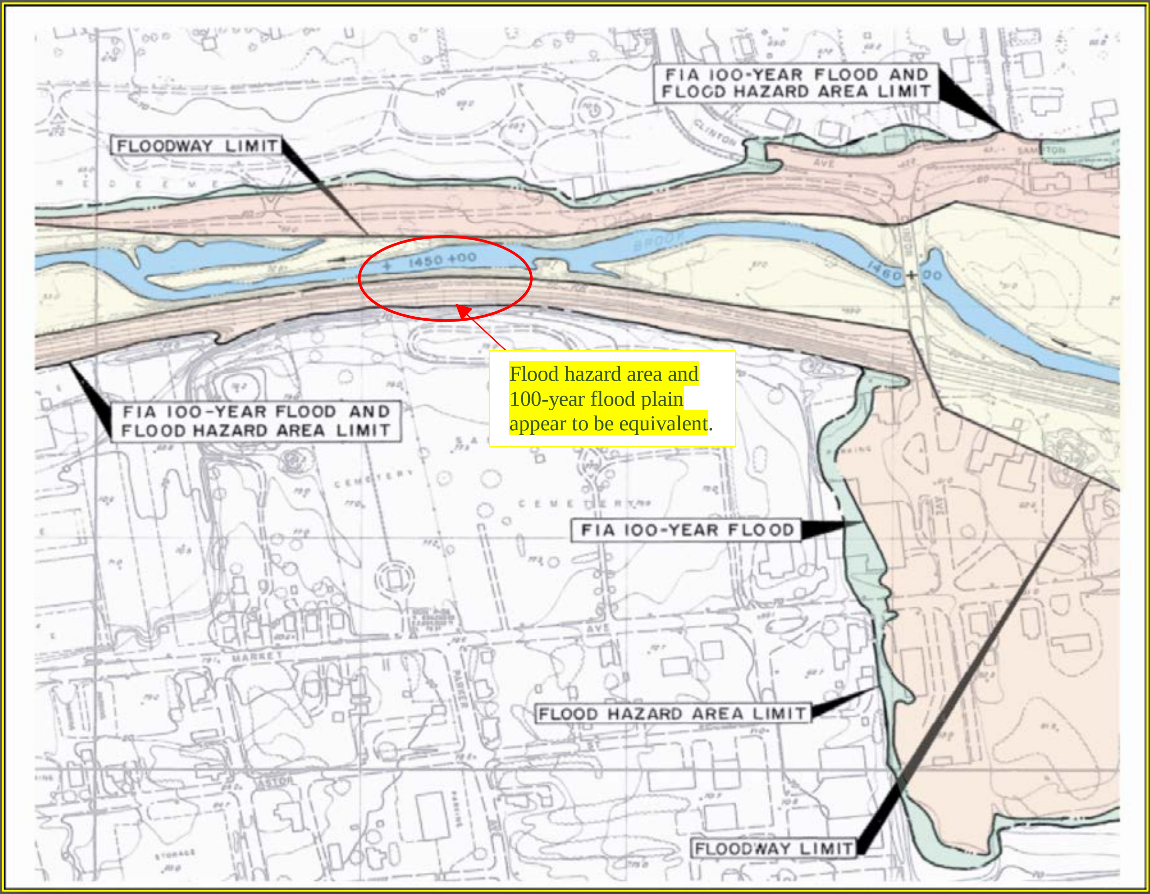
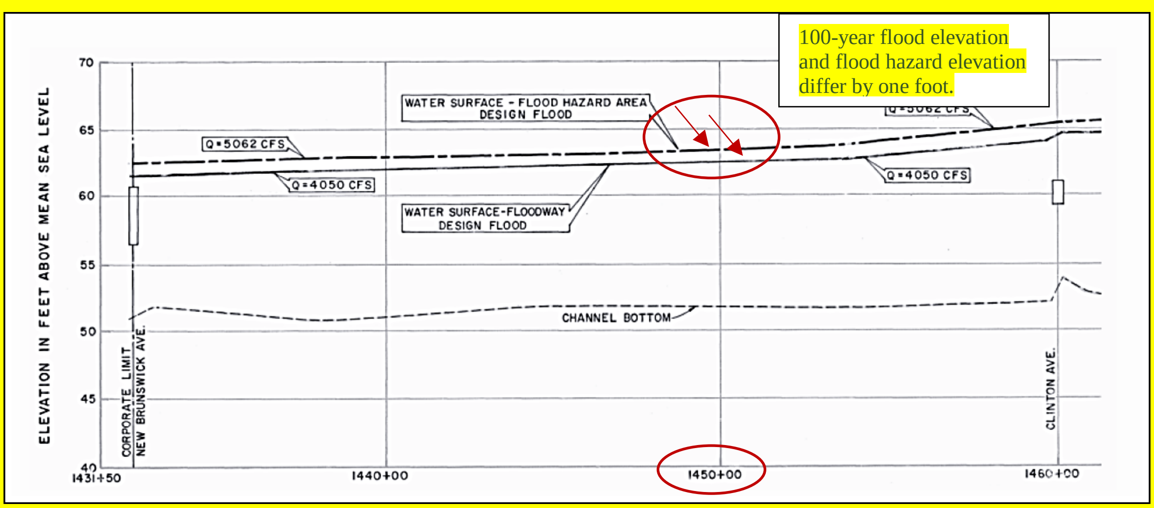


Figure 4.8: The Importance of Profile View



Some delineation methods require the use of factors of safety when determining the flood hazard area design flood elevation, but this is not necessary for Method 1 because a factor of safety has already been built into these delineations in the form of a 25 percent increase in the 100-year peak flow rate. The resulting flow rate was used to calculate the flood hazard area design flood elevation. This is illustrated by the flow rates shown in Figure 4.6 and Figure 4.8 where the 100-year flow rate is 4,050 cubic feet per second while the flood hazard area design flood elevation (based on a 25 percent greater peak flow rate) is 5,062 cubic feet per second.

When using Method 1, the site plan must be compared with the Department delineation for consistency after the flood information has been plotted. If the plotted limits significantly differ from those shown on the Department delineation, this discrepancy must be resolved prior to establishing flood hazard area limits on the site. For example, either the Department delineation or the topographic survey prepared for the site plan may contain an error or the site may have been filled, legally or illegally, since the date the source mapping was published. If the site was altered without an authorizing permit, there may be a violation on site that must be rectified before any further work is performed.

The plotted floodway should never be located outside of the plotted flood hazard area on a site plan. The floodway limit is based on the 100-year flood while the flood hazard area limit is based on the 100-year flood plus a factor of safety. Therefore, the flood hazard limit area may either coincide with the floodway limit or be located beyond the floodway.

If an applicant disagrees with the flood hazard area design flood elevation and floodway limits shown on a Department delineation, an application can be made to the Department to revise the adopted mapping. This procedure is outlined at N.J.A.C. 7:13-3.7.

4.4.2 Methods 2, 3, and 4: FEMA Flood Mapping Methods

The Federal government, through FEMA, has mapped the extent (elevation) of the 100-year floodplain in many places in New Jersey in both fluvial and tidal flood hazard areas. FEMA information may be used to determine the flood hazard area and floodway on a site under certain circumstances via Method 2, Method 3, and Method 4. Please note that under N.J.A.C. 7:13-3.2(b), **these flood mapping methods cannot be used if a Department delineation for a given regulated water was promulgated on or after January 24, 2013.** Also, these flood mapping methods cannot be used if a Department delineation promulgated before January 24, 2013 shows more conservative information for both the flood elevation and floodway (i.e., a higher flood elevation and wider floodway limits).

Because the most conservative flood elevation and floodway limits are required, in some instances, information from a variety of maps must be combined to determine the regulatory flood elevation and the extent of the floodway, which is discussed further in the general information applicable to all FEMA flood mapping methods below. This information is followed by detailed discussions of

Method 2 (the FEMA tidal method), Method 3 (the FEMA fluvial method), and Method 4 (the FEMA hydraulic method).

Information Applicable to All FEMA Flood Mapping Methods

To use Methods 2, 3, or 4, FEMA flood maps and Flood Insurance Study (FIS) booklets are necessary. This information may be downloaded from https://msc.fema.gov/portal. Some general tips on how to use a FEMA flood map are provided below along with an explanation of how the Department utilizes updated FEMA mapping and a discussion of combining maps, as previously mentioned.

How to Use a FEMA Flood Map

Like Department Delineations, FEMA flood maps provide the 100-year flood elevation. However, not all FEMA maps provide the location of the floodway. When using any of the FEMA flood mapping methods, the 100-year flood elevation must be plotted on a site plan according to the topography shown on that site plan. The 100-year flood limit shown on the FEMA map cannot be transposed directly onto the plan. The actual extent of flooding on a site must be determined based on the ground elevation as compared with the flood hazard area design flood elevation. By contrast, the location of the floodway, where available, can be transposed directly from the FEMA map.

If the plotted limits significantly differ from those shown on the FEMA mapping (other than adding one foot to the 100-year flood elevation if using Method 3), this discrepancy must be resolved prior to establishing flood hazard area limits on the site. For example, there may be an error in either the Department delineation or the topographic survey prepared for the site plan or a site may have been filled, legally or illegally, since the date the source mapping was published. If the site was altered without an authorizing permit, there may be a violation on the site that must be rectified before any further work is performed.

THE PLOTTED FLOODWAY SHOULD NEVER BE LOCATED OUTSIDE OF THE PLOTTED FLOOD HAZARD AREA ON A SITE PLAN.

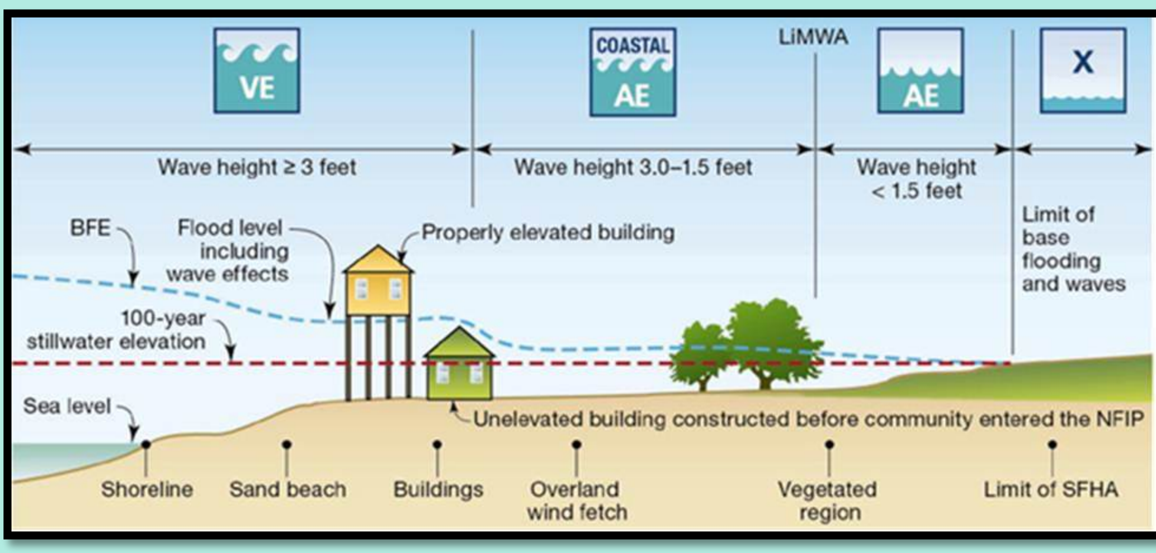
The plotted floodway should never be located outside of the plotted flood hazard area on a site plan. The floodway limit is based on the 100-year flood while the flood hazard area limit is based on the 100-year flood plus a factor of safety. Therefore, the flood hazard limit area may either coincide with the floodway limit or be located beyond the floodway.

FEMA flood mapping also depicts the appropriate flood zone for the area in question. In tidal areas, flood elevations are determined by computing the 100-year stillwater elevation, which is primarily a function of lunar activity and barometric pressure, along with the anticipated wave effect. Where anticipated wave heights exceed 3.0 feet, the area is demarcated as a *V zone*. Due to the high potential for flood damage in this area, development within V zones is restricted under the National Flood Insurance Program (NFIP) and is in some cases prohibited under both the Department's CZM Rules as well as the FHACA Rules.

The portion of a tidal flood hazard area located outside a V zone is referred to as an *A zone*. Inland flood hazard areas within the 100-year floodplain are also referred to as A zones. Where flood elevations have been calculated, the A zone is more commonly known as an AE zone. Areas where 100-year flood elevations have not been determined are shown on FEMA mapping as unnumbered A zones. A subset of an A zone where anticipated wave heights lie between 1.5 and 3.0 feet is denoted as a *Coastal A zone*. On FEMA mapping, the Coastal A zone captures the entire area within the Limit of Moderate Wave Action (LiMWA).

Figure 4.9, provided by FEMA, depicts the differences between these zones. Note that in this diagram, the V zone is referred to as "VE," and the A zones are referred to as "AE," indicating that FEMA provides a 100-year flood elevation for these areas. "BFE" means the base flood elevation, which is the stillwater elevation adjusted for wave height and corresponds to the 100-year flood elevation shown on the FEMA mapping. "SFHA" refers to a Special Flood Hazard Area. With respect to the SFHA, note that FEMA regulates flood hazard areas separately from the Department. As a result, the SFHA refers to areas where the NFIP's regulations are enforced and mandatory flood insurance must be purchased. These regulations and requirements must be observed in addition to those found in the FHACA Rules and are not discussed further in this manual.

Figure 4.9: FEMA's Flood Zone Designations



Newer FEMA mapping and FIS booklets also depict flood events in terms of probability, referring to the 100-year flood as the 1 percent flood and the 500-year flood as the 0.2 percent flood. (Refer to Section 4.1 for a discussion of these concepts.) Areas located outside the 1 percent floodplain but within the 0.2 percent floodplain lie within an *X zone*.

In addition to A zones, AE zones, V zones, VE zones, Coastal A zones, and X zones, FEMA utilizes other flood designations, including AH zones and AO zones. An AH zone refers to flooding in the form of ponded areas, and an AO zone refers to flooding due to overland flow of runoff.

Documentation on the FEMA flood map indicates that the flood depths in both the AH and AO zones are, on average, one to three feet. For the purposes of the FHACA Rules, when FEMA mapping shows AH and AO zones associated with regulated waters, a flood depth of three feet must be assumed when determining the 100-year flood elevation to be sufficiently protective of both the proposed project and neighboring properties. Thus, in fluvial flood hazard areas, the flood hazard design flood elevation will be four feet deep (one foot deeper than FEMA's 100-year flood elevation).

In the case of a flat site, the flood depth should be measured from the highest elevation on site, excluding any localized mounds that may exist on site that are otherwise inconsistent with the typical grade of the majority of the site. In this case, the flood elevation will be constant. For a site with a slope, the flood depth should be measured from existing grade, again ignoring atypical or localized topographic depressions or mounds that are inconsistent with the remainder of the site elevations. This will result in a flood elevation with a slope. In both cases, one foot must be added to FEMA's elevation to determine the fluvial flood hazard elevation for the purposes of the FHACA Rules.

Updated FEMA Maps

Periodically, FEMA will revise its flood mapping. Historically, FEMA mapping relied on NGVD (National Geodetic Vertical Datum of 1929), which is a universally recognized measurement of elevation above a point roughly equal to sea level. However, most of the more recent FEMA maps utilize NAVD (North American Vertical Datum of 1988). This distinction is important because all topography on a site plan must reference the same datum as the accompanying reference flood study unless the appropriate conversion factor is included on the plan. FEMA provides information on the relationship between NGVD and NAVD at https://www.fema.gov/media-library-data/20130726-1755-25045-0634/ngvd_navd.pdf. Additionally, NOAA provides an application to convert from one datum to another at https://www.ngs.noaa.gov/TOOLS/Vertcon/vertcon.html. However, all vertical datum conversion factors should be verified by a professional land surveyor who is licensed to practice in New Jersey.

Over the past several years, FEMA has been undertaking a comprehensive remapping of tidal flood elevations along New Jersey's coastline in cooperation with the Department.

Over the past several years, FEMA has been undertaking a comprehensive remapping of tidal flood elevations along New Jersey's coastline in cooperation with the Department. FEMA's flood elevation models for many coastal communities were developed decades ago using various methodologies that resulted in a patchwork of flood insurance rate maps with a variety of flood elevations. Using a uniform modeling approach and relying on data collected over the past several decades, FEMA has confirmed that its previous flood mapping along New Jersey's coastline generally underestimates today's 100-year flood elevation by several feet in some cases.

The remapping process has consisted of publishing Advisory Base Flood Elevations (ABFEs), then replacing these advisory maps with preliminary maps, and finally making the preliminary maps effective by publishing them in the Federal Register. The process has taken considerable time as FEMA has held public hearings and undergone an appeals process. Therefore, while this process has been completed in some of the southern portions of New Jersey, it has not been completed in some of the northern portions of the State, such as the Hudson River.

At present, FEMA has largely replaced the advisory maps with preliminary maps, which more accurately depict anticipated tidal flood elevations than the currently effective maps. These preliminary maps must be used instead of advisory maps where they are available. Note that once the preliminary maps are adopted by FEMA, these maps become the effective maps and will be the only maps acceptable for FEMA mapping methods unless and until new preliminary maps are developed. Advisory or preliminary maps (whichever is more recent for the site in question) that have not be superseded by a new effective map must be used where these maps depict higher flood elevations, wider floodway limits, or greater flow rates than depicted in the most recent effective FEMA Flood Insurance Study or when they indicate a change from an A zone to a V zone or coastal A zone.

Currently, the Department is working with FEMA to unify Federal and State flood mapping (Department delineations). As a result, some preliminary FEMA maps include New Jersey's flood hazard area design flood elevation. Figure 4.10 below shows an example (the flood hazard area design flood elevation is labeled "NJFHADF" and the flood hazard limit is marked by a black and white line). The corresponding flood profile view is shown in Figure 4.11 on the next page (the flood hazard area design flood elevation is still labeled as "NJFHADF" and is marked by a dashed line).

Figure 4.10: FEMA Map Showing the Limit of the New Jersey Flood Hazard Area Design Flood

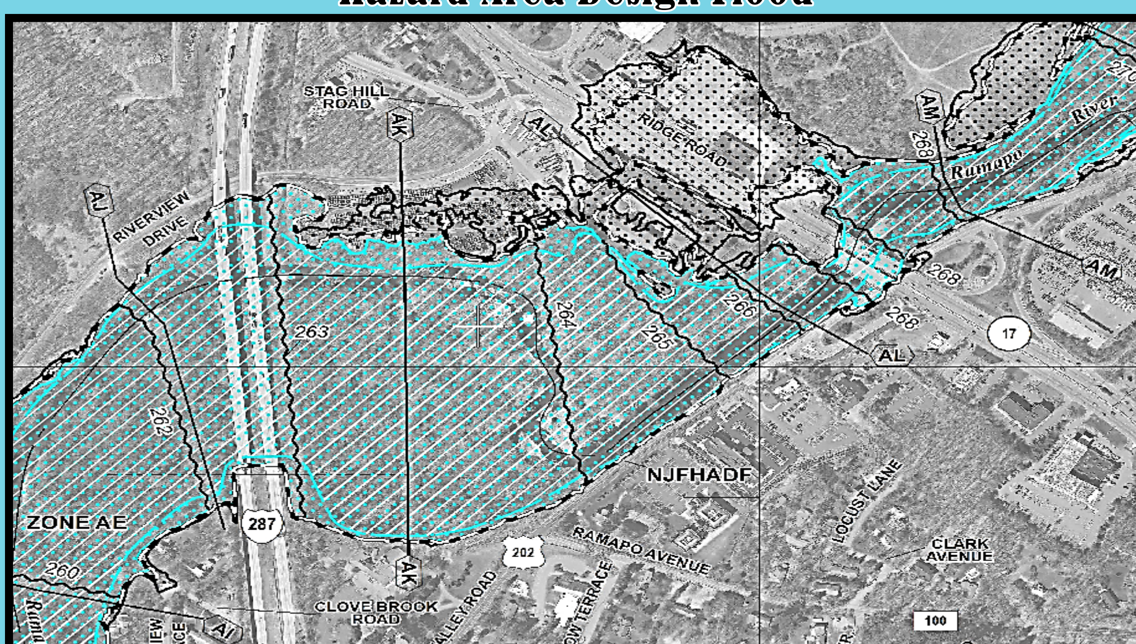
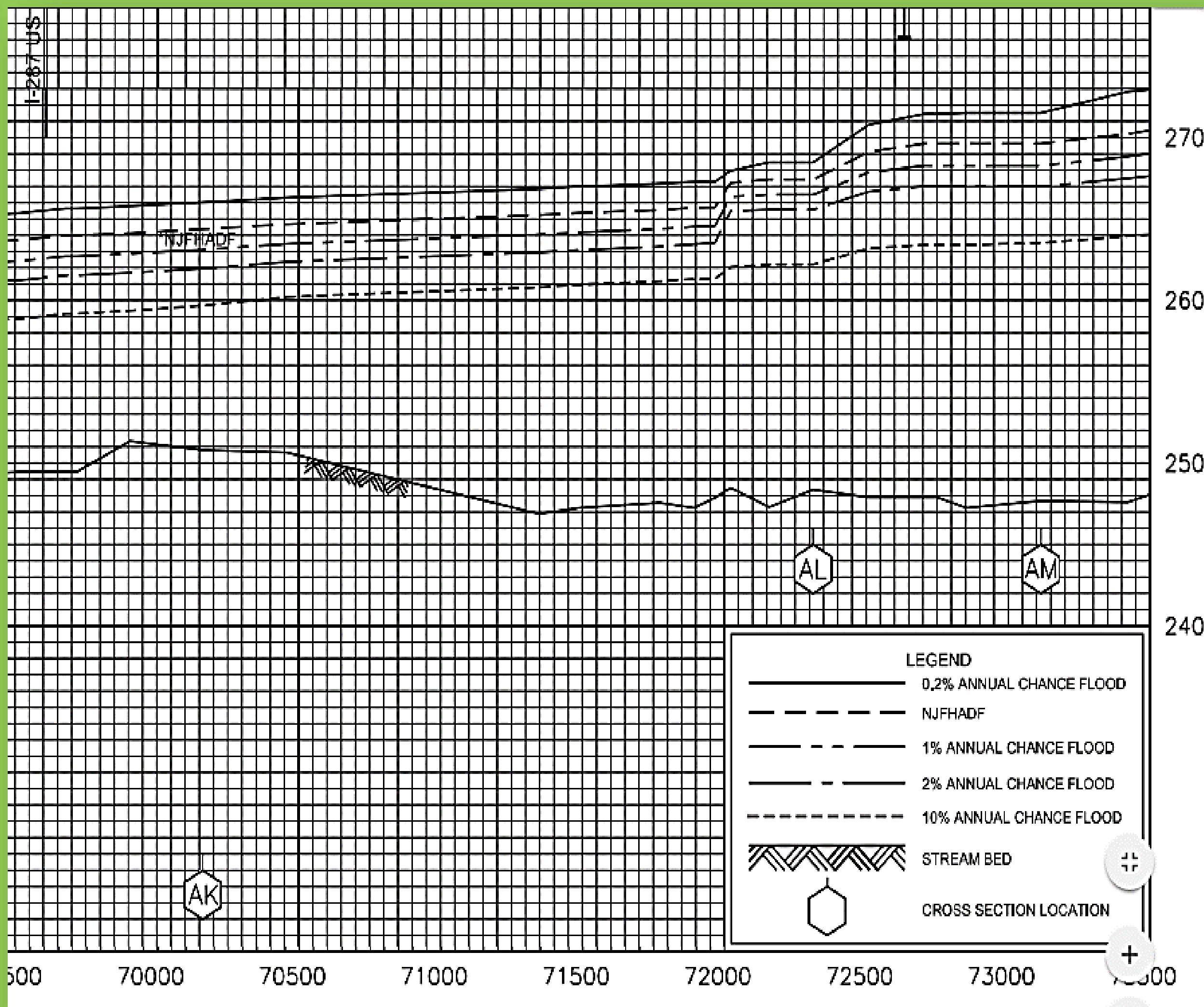


Figure 4.11: FEMA Flood Profile Including the Limit of the New Jersey Flood Hazard Area Design Flood Elevation



While this FEMA map depicts the New Jersey Flood Hazard Area Design flood, while it remains in "preliminary" status, the NJFHADF information may not be used for any regulatory purposes because a preliminary FEMA map cannot replace a promulgated Department delineation. This map can only be used to obtain a floodway limit and a 100-year flood elevation that can be converted to a flood hazard elevation via Method 2 and Method 3. To use the New Jersey Flood Hazard Area Design flood information shown on this map, the map must first be made effective. At this point, it will replace a Department delineation.

Combining Maps

In some cases, different FEMA flood maps and/or Department delineations (see Section 4.4.1 for Method 1) must be combined to determine the extent of the flood hazard area, base flood elevations, and zone designations. When FEMA maps and/or Department delineations are consulted, all maps must be compared. The mapping with the highest flood elevation must be used to determine the flood hazard design flood elevation, and the mapping showing the widest floodway must be used to establish the regulatory floodway limit for use under the FHACA Rules. Occasionally, multiple maps must be used to establish regulatory boundaries.

For example, with respect to FEMA mapping, sometimes an effective map shows a higher flood elevation but less severe zone designation (e.g., V zone, Coastal A zone) than a preliminary map or vice versa (see the discussion of updated FEMA maps above for an explanation of effective and preliminary maps). In these cases, information from both maps must be combined to yield the higher flood elevation, wider floodway limit, and more severe zone designation.

Similarly, Method 1 may show a higher flood elevation, but Method 2 or Method 3 may show a wider floodway limit or vice versa. In this situation, information from both methods must be combined to ensure that the highest flood elevation and widest floodway are used.

However, where a Department delineation was promulgated after January 24, 2013, only the Department delineation may be used, as specified at N.J.A.C. 7:13-3.2(b). Effective FEMA maps that show the New Jersey flood hazard limit will serve to replace Department delineations, as described in the discussion of updated FEMA maps above. In contrast, while preliminary FEMA maps that show this information are regulatory, they do not replace Department delineations. Instead, they are used in the same way as other FEMA mapping, which is to obtain a floodway limit and a 100-year flood elevation that is then converted to a flood hazard design flood elevation for Methods 2 or 3. For a FEMA map that shows the New Jersey flood hazard limit to replace an existing, promulgated Department delineation, it must first be made effective.

Method 2: FEMA Tidal Method

The FEMA tidal method applies along regulated waters for which FEMA has established a tidal 100-year flood elevation. Only FEMA documents that provide a 100-year flood elevation may be used for this method. The Department cannot accept a flood hazard area based on an unnumbered A zone because this does not provide a corresponding 100-year flood elevation.

Under Method 2, the flood hazard area design flood elevation is equal to the FEMA 100-year flood elevation. There is no factor of safety added to the 100-year flood elevation in tidal areas. Such a factor of safety is not required by rule because tidal flood elevations are not expected to increase for the entire Atlantic Ocean Basin as a result of development in New Jersey.

A floodway location is not provided for many tidal waters studied by FEMA. Where a regulated water with a tidally controlled flood hazard area is mapped by FEMA but a floodway is not shown on the FEMA map, N.J.A.C. 7:13-3.4(d)2(ii) specifies that the floodway limit will be equal to the top of bank of that water. However, not all watercourses shown within a tidal flood hazard area will have floodways located at the top of bank. FEMA must have published a flood study for that particular watercourse; otherwise, it is not a mapped watercourse, and its floodway limits may not be assumed to be located at the top of bank. In this case, Method 6 must be used for this tributary instead of Method 2 (see Section 4.4.4).

Note that the Atlantic Ocean and other non-linear tidal waters, such as bays and inlets, do not have a regulated floodway, as explained at N.J.A.C. 7:13-2.3(b).

Figure 4.12 below shows an example of a FEMA tidal flood map. Based on topography available when this map was created, FEMA determined that the area on this map shown with blue dots (the entire community in this case) lies below the 100-year flood elevation. However, as previously noted, the actual extent of flooding on a site must be determined based on the ground elevation as compared with the design flood elevation even if available flood mapping indicates that an area lies within (or outside of) the flood hazard area. Also, in this example, the 100-year flood elevation ranges from 6 feet NAVD along the bay to 12 feet NAVD in some locations along the ocean. A thin white line separates the areas on this map with different flood elevations.

Figure 4.12: FEMA Map Showing a Tidally Controlled Flood Hazard Area

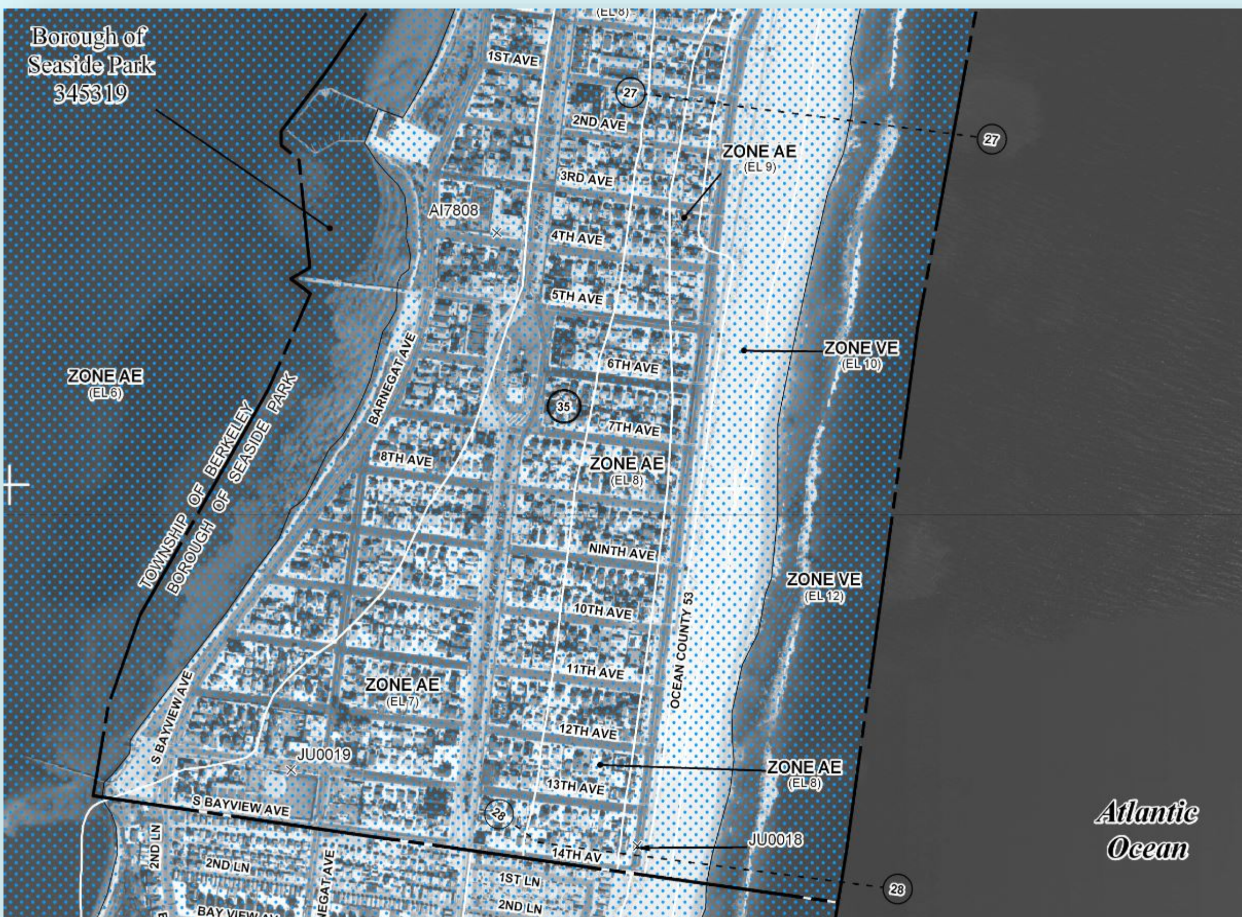
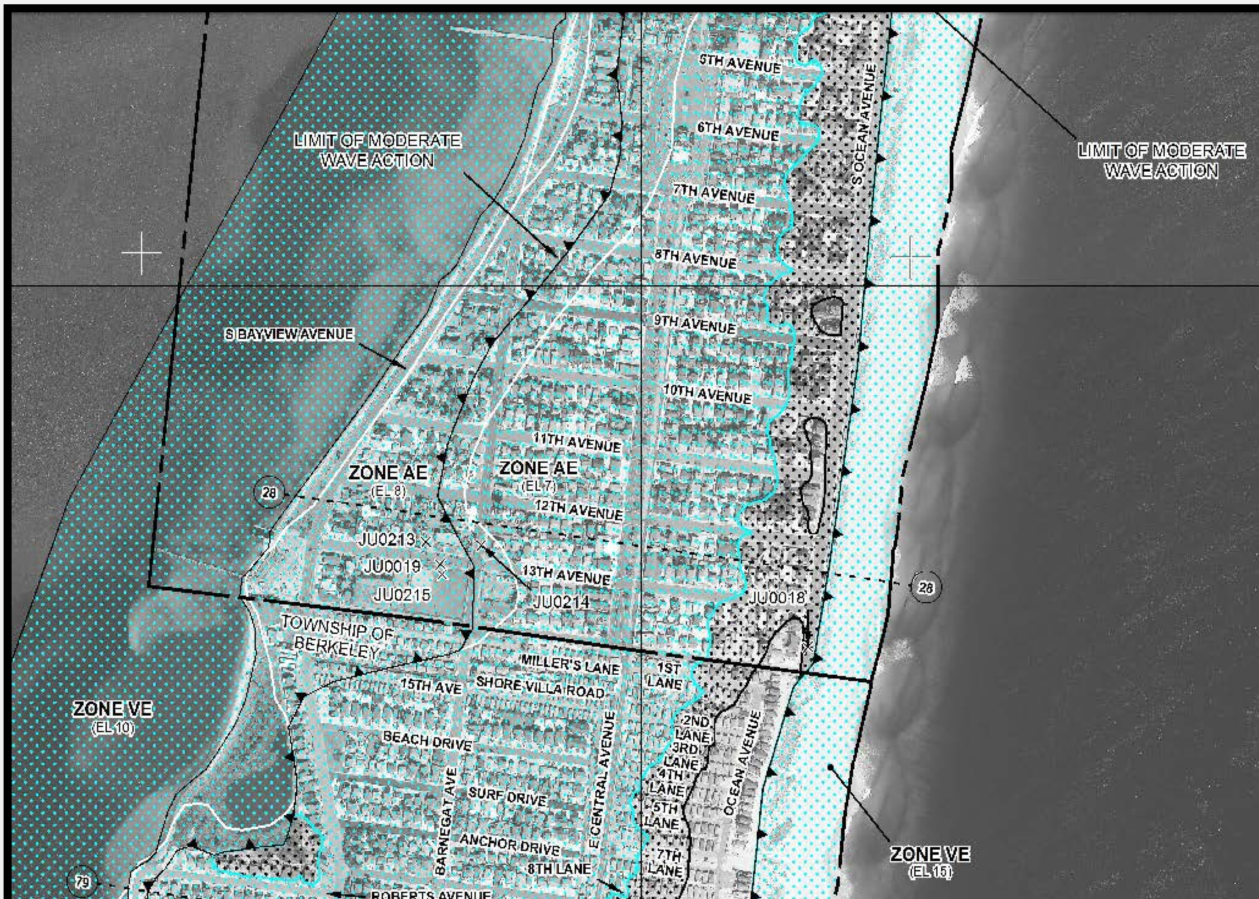


Figure 4.13 below depicts a FEMA preliminary map for the same area depicted in the effective map shown in Figure 4.12 (see the discussion of updated FEMA maps above for more information on preliminary vs. effective maps). Note the V and A zone designations as well as the LiMWA (the black line with triangles), which demarcates the limit of the Coastal A zone, as explained above in the discussion of how to use a FEMA flood map. Note also that, in this example, the flood elevations and the extent of the flood hazard area have been revised by FEMA and differ from the elevations shown on the effective map shown in Figure 4.12. Again, in areas where a preliminary map shows a higher flood elevation than the effective map, the preliminary map will govern over the effective map. Conversely, in areas where an effective map shows a higher elevation, the effective map will govern. The same applies to the flood zone designations where the more conservative flood zone designation on a given site must be used (e.g., V zone over a Coastal A zone). All mapping sources must be checked, which may lead to mixing and matching of information from different published mapping sources to utilize all of the most conservative information, as described in the discussion of combining FEMA mapping methods with a Department delineation, above.

Figure 4.13: Updated Preliminary FEMA Map Showing a Tidally Controlled Flood Hazard Area

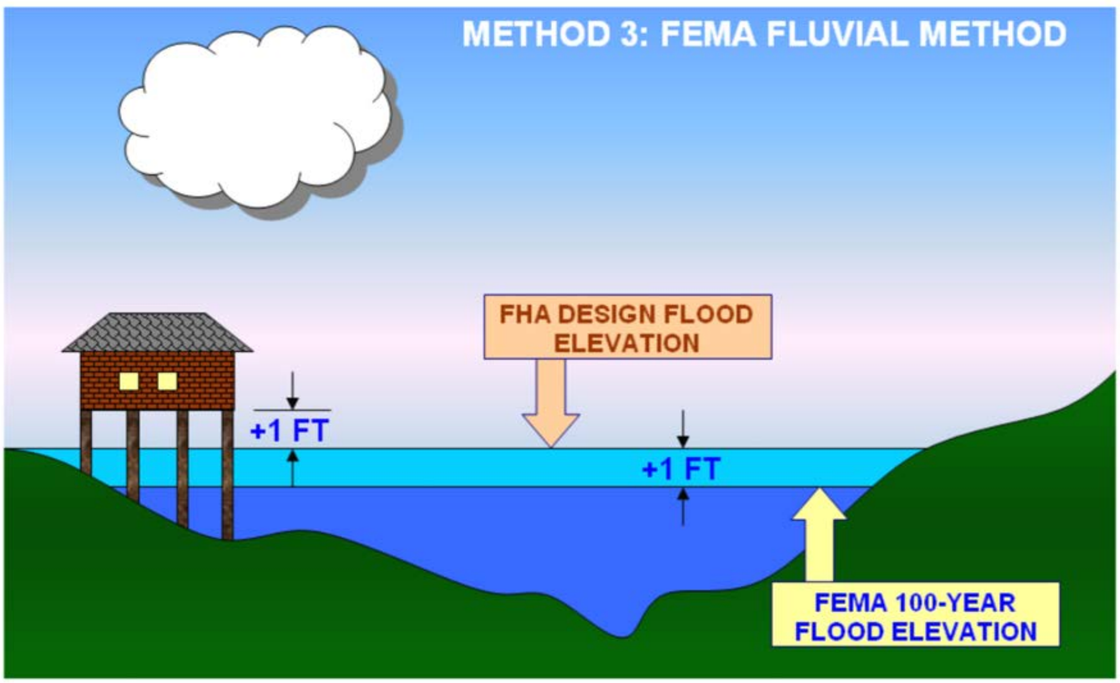


Method 3: FEMA Fluvial Method

The FEMA fluvial method applies in areas where FEMA has established a non-tidal 100-year flood elevation. Only FEMA documents that provide a 100-year flood elevation may be used for this method. Under N.J.A.C. 7:13-3.4(b), the Department cannot accept a flood hazard area based on other FEMA information, such as an unnumbered A zone, because it does not provide a 100-year flood elevation.

Under this method, the flood hazard area design flood elevation is equal to an elevation one foot above the FEMA 100-year flood elevation, as shown in Figure 4.14 below. Increasing the 100-year elevation by one foot is a factor of safety meant to ensure that the public is adequately protected as fluvial flood elevations rise over time.

Figure 4.14: Determining the Flood Hazard Design Flood Elevation Based on Method 3



Unlike the 100-year flood elevation, the floodway limit is equal to that shown on the FEMA map. If a FEMA floodway map does not exist for the section of regulated water in question, Method 3 cannot be used to determine the limits of the floodway. In such a case, N.J.A.C. 7:13-3.4(e)2(ii) specifies that Method 4 must be used to calculate the floodway limits. Note that it is not always necessary to know the floodway limits to demonstrate compliance with the requirements of the FHACA Rules. See N.J.A.C. 7:13-5.5 for cases when the floodway must be delineated before the Department can issue an individual permit or an authorization under a general permit.

Figure 4.15 below shows an example of a FEMA map for a fluvial area. The area covered with blue dots is FEMA's indication of the extent of the 100-year flood. However, as previously noted, the actual extent of flooding on a site may only be determined based on the ground elevation as compared with the flood hazard area design flood elevation even if the FEMA map shows the area is located within or outside of the flood hazard area. Therefore, the actual limit of flooding needs to be determined by plotting the flood hazard design flood elevation (obtained by adding one foot to the 100-year flood elevation shown in the FIS booklet) on a site plan.

Figure 4.15: FEMA Map Showing a Fluvially Controlled Flood Hazard Area

In Figure 4.15, the 100-year flood elevation varies from 190 feet NAVD to 184 feet NAVD. The corresponding flood hazard elevations would then vary from 191 feet NAVD to 185 feet NAVD. The wavy black line below each elevation indicates the location where the corresponding flood elevation occurs. To more accurately determine the 100-year flood elevation from the FEMA map, the corresponding flood profile located in the FIS booklet must be utilized. **It is the elevation(s) from the FIS to which one foot must be added to determine the flood hazard elevation under Method 3.**

Method 4: FEMA Hydraulic Method

This method is only appropriate in one of the following situations:

Where FEMA has published peak flow rates (see Section 4.5.1) and a project requires hydraulic calculations to compare preconstruction and postconstruction water surface elevations to demonstrate that there will be no offsite flooding, per N.J.A.C. 7:13-12.1 and N.J.A.C. 7:13-12.7 (see Section 4.6 for examples of projects that require hydraulic calculations)

OR

Where Method 3 is utilized but FEMA did not calculate the floodway limits

In cases where Method 4 is appropriate, the FEMA 100-year flow rate is used to determine both the flood hazard area design flood elevation and the location of the floodway for a tidal flood hazard area. For this method, 125 percent of the FEMA 100-year flow rate is used to determine the flood hazard area design flood elevation for a fluvial flood hazard area while the published 100-year flow rate is used to determine the location of the floodway. Again, the additional flow required to determine the flood hazard area of a fluvial watercourse is required as a factor of safety necessary to prepare for future increases in fluvial flood elevations due to continued development.

Note that Method 4 may only be utilized where the FEMA flood insurance study provides a 100-year flow rate for the regulated water. Where FEMA has not published a flow rate for a particular watercourse, Method 4 cannot be used for that watercourse.

To utilize Method 4, the flood hazard area design flood elevation must be based on a hydraulic analysis (see Section 4.6), such as a standard step backwater analysis, using the appropriate flow rates from the FEMA study.

The floodway limit must be determined by a hydraulic analysis for all fluvial waters and linear tidal waters (non-linear tidal waters do not have a floodway, as explained in the discussion of Method 2) using the 100-year flow rate reported by FEMA for the regulated water, assuming a maximum rise of 0.2 feet in the 100-year flood elevation and an equal conveyance reduction unless the applicant demonstrates that due to the topography of the area, the proximity of structures to the channel, and/or other physical characteristics of the drainage area or flood hazard area, use of something other than an equal conveyance reduction will more optimally calculate the floodway limits at a given location. Note that in cases where floodway calculations indicate a decrease in water surface elevations, the entire flood hazard area (at cross-sections depicting the calculated decrease) will be considered the floodway, as stated at N.J.A.C. 7:13-3.4(f). Calculating the floodway is discussed in greater detail in Section 4.7.

4.4.3 Method 5: Approximation Method

According to N.J.A.C. 7:13-3.5(a), when neither a Department delineation nor FEMA mapping is available, Method 5 can be used to provide a conservative estimate of the flood hazard area elevation on a site, provided the drainage area of the water is less than 30 square miles.

In some cases, applicants do not need an exact delineation of the flood hazard area on their site to determine compliance with the FHACA Rules and therefore find it unnecessarily burdensome to calculate the precise flood hazard area limits. Examples include sites with a measure of topographic relief and those with multiple locations around the site that could serve as the location for the proposed project. In these cases, Method 5 provides a simplified, conservative technique to calculate the limits. While Method 5 can be beneficial in certain circumstances, its usage is never compulsory. Rather, it is an optional alternative to the more rigorous Method 6 where appropriate.

Directions concerning how to use Method 5 can be found in Appendix 1 of N.J.A.C. 7:13 and are explained in further detail in this section of the manual. If there are any discrepancies between the two, Appendix 1 will govern. Please note that all references to appendices in this discussion of Method 5 refer to appendices located in the FHACA Rules, not to the appendices located in this manual. The appendices in the FHACA Rules are denoted with numbers while the appendices in this manual are denoted with letters to avoid confusion.

To utilize Method 5, a topographic survey of the area in question must be obtained, and all of the following must be determined:

- The drainage area of the regulated water in question, most commonly via usage of the USGS map (see Section 2.1.3 for more information on how to determine drainage areas)
- The Watershed Management Area to which the regulated water belongs (which may be obtained through the Department's GeoWeb application at http://www.nj.gov/dep/gis/geowebsplash.htm)
- The elevations of any roads or other structures that cross the regulated water within one mile downstream of the site, such as dams, berms, or railroads

Method 5 is based on an extensive analysis of United States Geological Survey (USGS) data, FEMA flood insurance studies, and methods used by other states to approximate flood hazard areas. Data was collected from every detailed, effective FEMA flood insurance study in the State as of 2007 to generate a logarithmic relationship between flood depth and drainage area. Equations were generated for each of the State's Watershed Management Areas (shown in Figure 5 in Appendix 1 of N.J.A.C. 7:13 and in Figure 7.2 of this manual) with an added factor of safety to ensure that the actual flooding along a given water will not be greater than this method approximates. The final computed values are shown in Table 1 in Appendix 1 of N.J.A.C. 7:13.

A Note of Caution

Method 5 has limitations. While it provides an approximate flood hazard area design flood depth from which the limits of a flood hazard area can be determined, it does not provide a floodway limit. Should the floodway limit be required to determine compliance with the FHACA Rules, Method 5 may not be used. The conditions under which the Department can approve an authorization under a general permit or an individual permit in an approximated flood hazard area are located at N.J.A.C. 7:13-3.5.

The size of the watershed of the regulated water is also a limitation of Method 5. This method was designed to determine flood depths where the size of the watershed is less than 30 square miles. However, most regulated waters of this size have already been delineated by the State or FEMA, and therefore, this limitation should not be encountered frequently.

In addition to the values obtained from Table 1, the presence of any roadways and other water control structures that may cross the water downstream of the site must be considered when approximating the depth of flooding. If a culvert or bridge is located downstream of a site, floodwaters may back up and even overtop the roadway. In such a case, the depth of flooding can be higher on a site than indicated by Table 1. While some road crossings are designed to pass the flood hazard area design flood, most crossings will cause some impediment to flow and will therefore raise flood elevations upstream of the roadway to some degree. Railroad crossings, dams, and other water control structures have a similar effect. In the absence of hydraulic calculations for each structure, the conservative assumption must therefore be made that any road crossing or other water control structure will impede flow and increase flooding to the point that water actually overtops the road surface. As such, the elevation of the lowest point of each roadway or other water control structure (known as the *low point*) crossing the regulated water within one mile downstream of the site must be determined. Using Table 2 in Appendix 1 of N.J.A.C. 7:13, the flood depth in the vicinity of the crossing will be between one and three feet above the crossing's low point, depending on the drainage area of the water. These depths were calculated using typical road profiles and flow rates for watercourses of various drainage areas.

In the Department's experience, water control structures more than one mile downstream of a project rarely have a significant impact on flooding on the site and therefore do not need to be considered. However, if the Department is aware of an unusual condition that would affect flooding, such as an extremely large and/or inadequate water control structure more than one mile downstream, Method 5 cannot be used to determine the flood hazard limit because Method 5 may inadvertently underestimate the limit of the flood hazard area. Instead, the flood hazard area limit must be calculated according to Method 6 (see Section 4.4.4).

It is important to note that when using Method 5, an applicant must utilize the higher flood elevation that results from each of the two evaluations discussed above. First, the flood depth obtained from Table 1 in Appendix 1 is added to the average streambed elevations on or along a project site to obtain a flood elevation at each location. Then, the elevation obtained using Table 2 in Appendix 2 is compared to the flood elevations obtained from Table 1, and the higher of the two elevations will be the regulatory flood hazard elevation at each location. As a result, the flood hazard design flood elevation determined by Method 5 along any given site may be based on either the size of the contributory drainage area, the backwater from a downstream water control structure, or even a combination of the two.

To illustrate the use of this method, assume an applicant wishes to construct a house at a particular location along a regulated water and wants to determine the approximate flood depth at that location. The regulated water has a drainage area of 1.9 square miles. The site is located in Watershed Management Area 5. Table 1 in Appendix 1 gives a flood depth of 9 feet above the average channel bed. The average bed elevation nearest to the house has been found to be 100 feet NAVD. Therefore, the approximate flood elevation according to Table 1 would be 109 feet NAVD at the proposed house site. However, two roads cross the regulated water within one mile downstream of the site. The low point of the first is 105 feet NAVD, and the low point of the second is 108 feet NAVD. For a drainage area of 1.9 square miles, Table 2 gives a flood depth of two feet over the low-point of the roadway. The approximate flood elevations at these roadways would therefore be 107 feet NAVD and 110 feet NAVD, respectively. Of all three elevations (109 feet NAVD from Table 1, 107 feet NAVD from Table 2, and 110 feet NAVD from Table 2), 110 feet NAVD is the highest. Therefore, the approximate flood elevation at the proposed house site is 110 feet NAVD.

In some cases, an applicant may establish a flood hazard area limit that is even more conservative than the limit derived from Method 5. For example, a freshwater wetlands transition area limit may have been established by metes and bounds outside the approximated flood hazard area limit, and the transition area limit could be used as the approximate flood hazard area limit to save the time and money associated with establishing a separate flood hazard area limit with metes and bounds onsite.

4.4.4 Method 6: Calculation Method

Unless a Department delineation adopted on or after January 24, 2013 exists (in which case that delineation must be used), Method 6 may be used to determine the flood hazard area design flood elevation and floodway limits, even if FEMA flood mapping is available, irrespective of the authorizing date of the FEMA map. However, if neither a Department delineation nor a FEMA study is available, or if the approximation method described above (see Section 4.4.3) cannot be used, the flood hazard area design flood elevation and floodway limits can only be determined using the calculation method (Method 6). Method 6 is explained at N.J.A.C. 7:13-3.6.

In a fluvial flood hazard area, there are two steps for calculating the flood hazard area design flood elevation for a regulated water.

Step 1

Perform a hydrologic analysis to determine the peak flow rates for the floods to be calculated for the regulated water if steady flow conditions are to be assumed. These floods will typically include a range of events including 2, 10, 25, 50, and 100-year floods. The hydrologic analysis must assume existing development conditions in the drainage area as of the date of the application to the Department. See Section 4.5 for information on determining flow rates and hydrographs.

Step 2

Perform a hydraulic analysis, such as a standard step backwater analysis, using 125 percent of the 100-year flow rate determined in STEP 1 to determine the flood hazard area design flood elevation. See Section 4.6 for information on hydraulic analyses.

To determine the floodway limit in a fluvial flood hazard area, a hydraulic analysis, such as a standard step backwater analysis, must be performed using the 100-year flow rate determined in Step 1 above, assuming a maximum rise of 0.2 feet in the non-encroached 100-year flood elevation. The floodway limits must be calculated assuming equal conveyance reduction unless the applicant demonstrates (prior to submitting an application for a verification to the Department) that use of another floodway limit method will more accurately calculate the floodway limits at a given location due to the topography of the area, the proximity of structures to the channel, and/or other physical characteristics of the watershed or flood hazard area. See Section 4.7 for more information about calculating the floodway limits.

For a watercourse located in an area where both fluvial and tidal flooding occurs, such as along a linear regulated water draining at least 50 acres that is inundated by tidal backwater during the 100-year flood and that is not studied by FEMA, it will be necessary to conduct a fluvial analysis to compare to the known tidal flood elevation. Use of Method 6 will determine whether the flood hazard area of such a watercourse is fluvial or tidally controlled. In a situation like this, the floodway may not be assumed to be located at the top of bank because it is not a mapped watercourse. Instead, the floodway must be computed under Method 6.

Method 6 can also be used to determine the limits of the 10-year floodplain, which is important for compliance with the flood volume displacement standards of N.J.A.C. 7:13-11.4. See Section 5.2.1 of this manual for more information. Finally, Method 6 may be used to compute additional peak flow rates, such as those corresponding to the 2, 25, and 50-year flood events, for use in determining compliance with offsite impact limitation standards, as required by N.J.A.C. 7:13-12.1(f), 12.1(g), and 12.7.

4.5 Establishing Peak Flow Rates and Computing Hydrographs

To calculate any flood elevation, the peak flow rate of the regulated water in question must first be established for the chosen design flood. To this point in this manual, emphasis has been placed on the 100-year and flood hazard area design floods since knowing these flood elevations is required to demonstrate compliance with a number of the regulatory requirements of N.J.A.C. 7:13. However, in addition to these flow rates, the flow rates for other floods must often be determined.

For example, to demonstrate compliance with the flood storage displacement standards of N.J.A.C. 7:13-11.4, it will typically be necessary to determine the 10-year flood elevation (see Section 5.2.1), which is calculated from the peak 10-year flow rate. Similarly, to demonstrate compliance with the State's Stormwater Management Rules at N.J.A.C. 7:8, it may also be necessary to determine both the peak 2-year and 10-year flow rates and hydrographs. For a channel modification (see Section 13.1) or the construction of a bridge or culvert (see Section 10), the peak 2-year, 10-year, 25-year, 50-year, 100-year, and flood hazard area flow rates and hydrographs must be determined.

Any flow rate may be taken from a known, published source (see Section 4.5.1) or may be established through calculations via the NRCS Method (see Section 4.5.2) or other methods (see Section 4.5.3). In certain circumstances, attenuation must be considered when calculating flow rates (see Section 4.5.4).

This manual does not seek to provide detailed explanations of the methodologies used in various hydrologic models but is instead intended to highlight various situations and caveats for the proper use of different techniques and to explain the information that must be submitted for applications for permits and verifications under N.J.A.C. 7:13 (see Section 4.8.1 for hydrologic reporting guidelines).

4.5.1 Published and Previously Calculated Flow Rates

Flow rates may be known from previously adopted or published studies. For example, both a Department delineation and a FEMA delineation may exist for a particular reach of a watercourse. If such a delineation exists for a given watercourse on a given site, it may be used to establish the flow rates of interest, provided certain conditions are met. In addition, data may exist via a previous permit issued by the Department. Explanations for how to determine flow rates from a Department delineation, a FEMA delineation, and a previous permit are provided below along with a discussion of how to utilize incomplete published data sets.

Department Delineation

The flow rates referenced in a Department delineation do not need to be modified in any way because the Department's flood hazard area design flow rates already contain a built-in factor of safety to account for any increased future flooding, as discussed in Section 4.4.1.

A Department delineation does not compute peak flow rates at every point along a watercourse. Instead, peak flow rates are computed at only a few locations. Often, a site will be located along a reach of watercourse in between two such locations. In these instances, the flow rate the Department used for that reach of the watercourse may be utilized, but it is not appropriate to interpolate between the two locations because interpolation may not accurately reflect how flow in the watercourse changes.

Department delineations may be used wherever they have been adopted. The hydrologic data presented in delineations dated on or after January 24, 2013 **must** be used and may not be substituted with calculations that re-compute any flow rate contained within those delineations. However, an applicant is not required to use hydrologic data for those delineations adopted prior to January 24, 2013. In fact, Department delineations adopted prior to January 24, 2013 cannot be used if they have been superseded by a more updated Department delineation or if any published FEMA studies indicate higher flood elevations or wider floodway limits. Where use of a Department delineation adopted prior to January 24, 2013 is acceptable but the applicant chooses not to use this data, hydrologic parameters would need to be calculated (see Section 4.5.2 for the NRCS method of calculation and Section 4.5.3 for other methods of calculation).

When using a Department delineation, the applicant must submit a photocopy of the portion of the hydraulic study that specifies the flow rate used in the reach of watercourse in question. This information can be found in the supporting calculations that accompany the Department delineations (see Section 4.4.1 for information on how to obtain a copy of a Department delineation).

FEMA Delineation

Unlike a Department delineation, to use a FEMA delineation, the applicant must adjust the 100-year peak flow rate along fluvial waters. FEMA delineations, whether advisory, effective, or preliminary (see the discussion of updated FEMA maps in Section 4.4.2 for more information on the types of FEMA maps) do not include any built-in factors of safety. Therefore, when a FEMA delineation is used for a fluvial flood hazard area, the published 100-year peak flow rate must be increased by 25 percent to arrive at the flood hazard area design flow rate.

However, no adjustments need to be made for other fluvial flood events because the required factor of safety is only a relevant concept with respect to the flood hazard area design flood flow rate, not to other flood events.

As is the case for Department delineations, FEMA does not compute peak flow rates at every point along a watercourse. Instead, peak flow rates are computed at different locations. When using FEMA's hydrology, site will often be located along a reach of watercourse in between two known values of peak flow rate. In these instances, the flow rate FEMA used for that reach of watercourse may be used, but it is not appropriate to interpolate between the two known values because interpolation may not accurately reflect how flow in the watercourse changes.

When using a FEMA delineation, the applicant must submit photocopies of the FIS booklet that depict the flow rates along the reach of watercourse in question. For the purposes of the FHACA Rules, and in keeping with the definition of "FEMA flood mapping" in N.J.A.C. 7:13-1.2, a FEMA delineation may only be used if it was published on or after January 31, 1980. Effective FEMA maps dated prior to January 31, 1980 may not be used.

Hydraulic Information from a Previous Permit

Rather than using a Department or FEMA delineation, an applicant may rely upon an existing flood hazard area verification or permit to establish a flow rate for use under Method 6 (described at N.J.A.C. 7:13-3.6 and in Section 4.4.4 of this manual), provided the data used in the previously approved flood hazard area verification or permit is still valid and the verification or permit has not expired. Prior to authorizing such data for use on a different site, the Department must review that data for accuracy. Therefore, the applicant needs to submit a copy of the hydrologic study upon which the verification or permit in question was authorized. If this information cannot be located, the verification or permit cannot be used to establish flow rates.

If an applicant wishes to use a verification or permit that is expired or to rely on hydrologic data approved under a previous version of N.J.A.C. 7:13, the applicant needs to confirm that the Department will allow the use of that data before submitting an application. In these cases, applicants are encouraged to contact the Department to discuss various options. The Department may require the applicant to update the data to satisfy the current requirements of N.J.A.C. 7:13.

Incomplete Published Data Sets

In certain instances, an applicant may wish to rely on published peak flow rate data but finds the data set to be incomplete. For example, FEMA delineations may include only the 10-year (10 percent), 50-year (2 percent), 100-year (1 percent), and 500-year (0.2 percent) peak flow rates, but certain types of projects, including a channel modification and the construction/reconstruction of a bridge or culvert, require knowledge of additional flow rates, including the 2-year (50 percent) and 25-year (4 percent) flow rates. In such cases, the missing flow rate data cannot be independently computed and used in conjunction with the published data because the independent computation would most likely rely upon a differing calculation methodology, and the resulting data set of flow rates would be inconsistent.

Therefore, the applicant may choose either to independently calculate every storm event under Method 6 (see Section 4.4.4) or to use the published peak flow rate data and supplement it to determine the missing peak flow rates of interest. For example, where FEMA has published 10, 50, 100, and 500-year peak flow rates, the 2-year peak flow rate may be derived via extrapolation directly from these published peak flow rates, and the 25-year peak flow rate may be directly derived via interpolation of these published peak flow rates. Such extrapolation and interpolation are based directly on the published peak flow rates as opposed to other variables, such as published rainfall amounts.

4.5.2 NRCS Method

In areas where no published flood study is available, peak flow rates for a given reach of watercourse must be determined through rainfall-runoff calculations performed by a New Jersey licensed professional engineer and submitted to the Department for review. The most common method for calculating flow rates is the rainfall-runoff method developed by the USDA's Natural Resources Conservation Service (NRCS). Many proprietary software programs utilize the NRCS methodology.

The most common procedure submitted to the Department for review is that described in the NRCS publication Technical Release 55 (TR-55), *Urban Hydrology for Small Watersheds*. The methodology described in TR-55 is derived from the NRCS's Technical Release 20 (TR-20). TR-55 describes procedures to calculate storm runoff volumes, peak discharge rates, and hydrographs required for flood analyses and delineations. It uses a hypothetical design storm and an empirical nonlinear runoff equation to compute runoff volumes and a dimensionless unit hydrograph to convert those volumes into runoff hydrographs. A complete description of the NRCS methodology can be found in the *NRCS National Engineering Handbook*, "Part 630- Hydrology" at https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=21422. A detailed discussion of TR-55 is available from the NRCS at https://www.wcc.nrcs.usda.gov/ftpref/wntsc/H&H/other/TR55documentation.pdf Refer to these resources for more detailed information concerning the basis of NRCS methodology.

For all programs using the NRCS methodology, the calculated flow rate will be based on the following, some of which are described in further detail below:

Antecedent moisture condition

New Jersey is under antecedent moisture condition 2.

Curve number

This is a reflection of land cover, which is best determined from GIS land coverages along with supplemental field investigation where necessary.

Time of concentration

Size of the drainage area

Rainfall depth

NRCS methodology relies on 24-hour rainfall depths, found here: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_018235.pdf.

Rainfall distribution

Type of unit hydrograph

Time of Concentration (t_c)

Applicants should consult Chapter 15 of Part 630 of the *National Engineering Handbook* for information relevant to the calculation of the time of concentration. This document outlines two primary methods developed by the NRCS to compute the time of concentration – the watershed lag method and the velocity method. The velocity method is recognized by the NRCS as the best computational method in urbanizing watersheds and in cases where hydraulic changes to a regulated water are proposed. As such, the velocity method is the Department's preferred method for computing the time of concentration in most cases.

Time of concentration mapping must be marked to depict the limits of sheet flow, shallow concentrated flow, and channel flow to the point(s) in question. Refer to Chapter 15 of the *National Engineering Handbook* for limitations and considerations in determining the time of concentration. Note that the information contained in the handbook differs from that shown in the 1986 publication of TR-55. Because the information in Chapter 15 is more updated than what is shown in TR-55, its guidance and usage supersede what is written in TR-55 concerning the time of concentration.

Size of the Drainage Area

Section 2.1.3 provides a general explanation of how to determine drainage area. The information presented here is specific to determining the size of a drainage area for the purpose of calculating flow rates.

Drainage area is determined by differentiating ridge and valley lines on a topographic map. The mapping required for submittal must clearly demonstrate that all areas outside of the depicted drainage area boundary drain away from the point of interest. In so doing, the limits of the drainage area may only be based on land slope.

In some cases, an applicant may wish to rely on the presence of existing stormwater collection systems to divert upgradient runoff from a point of interest, which would decrease the size of the drainage area. These diversions are generally not considered when determining flow rates because stormwater collection systems are not sized to handle all of the runoff from larger storm events, such as the 100-year or flood hazard area design storms, for all parts of an upgradient watershed. During larger floods, the collection systems will surcharge, in which case runoff then will follow the topography of the land and contribute to the amount of flow at the point of interest. However, if an applicant has detailed information to prove that some portion of the flow for larger storm events is diverted outside of the watershed, they may be able to reduce the total flow rate to account for this diversion. If there is detailed information that reflects that flow is diverted into the watershed from another watershed, the total drainage area must be increased to account for this diversion, and any portion of flow diverted into the watershed in question must be considered in the total flow rate.

It is also important to note that drainage areas may also have changed due to activities that are not reflected by the available topographic mapping. For example, portions of a drainage area may have been diverted by a State or Federally constructed flood control project. Similarly, depressed areas that formerly provided flood storage may have been re-contoured, and land uses outside of the applicant's property may have changed. Therefore, it is important to evaluate whether the topographic mapping used to establish the drainage area and other factors in the hydrologic computations are accurate as depicted.

Most commonly, the USGS map is used to determine the limits of the drainage area (as discussed in Section 2.1.3). However, there are instances where topography may be excessively flat and the USGS map is not adequate to determine adequate drainage area limits. In these cases, and in cases where the USGS map does not accurately reflect current topography, alternate mapping sources may be used. Field survey data may be used provided that the mapping upon which it is presented to the

Department is in the form of a scaled drawing, with a date and title block as required by N.J.A.C. 13:40-8, that is signed and sealed by a professional land surveyor licensed in New Jersey.

LiDAR data can be used to supplement other mapping. The applicant should consult first with the Department prior to obtaining the LiDAR data. Before the Department can authorize its usage, the applicant needs to be able to verify the validity of the LiDAR data.

As explained in Section 2.1.3, the drainage area muse be measured from the most downstream limit of the site, especially when the site is large. When the upstream property limit is used as the sole basis of measuring the contributory drainage area, the resultant flow rates will be underestimated because the applicant will have missed the remaining areas that contribute flow to the site. Flow rates may vary on very large sites, and at various locations throughout the property, through the use of multiple drainage areas (one at each point of interest), provided all areas tributary to the downstream point of each drainage area are included.

Note that the number of required drainage areas is a function of the hydrologic homogeneity of land upgradient of a site. A single drainage area should not be chosen to represent hydrologically dissimilar lands. Where a drainage area is not homogenous due to large variations in topography, land cover, or soils, an applicant must divide the drainage area into a series of more homogenous subareas for analysis. In these cases, the overall drainage area must first be divided into sub-areas and analyzed separately. Then, each separate flow rate should be combined to determine the total peak flow for the entire drainage area at the point of interest. Such combinations should be performed by adding the hydrographs for each subarea rather than just their peak flows. Adding peaks is another common mistake when computing runoff from multiple subareas. Adding subarea hydrographs accounts for the variation in time of concentration between subareas to be included in the resulting peak flow or hydrograph calculations.

Rainfall Distribution

The Type III rainfall distribution has historically been used in New Jersey. However, in 2012, the NRCS updated rainfall distributions, and the Type III rainfall distribution has been replaced by two separate rainfall distributions for use in TR-55 methodology, known as the Region C and Region D rainfall distributions. Region C is reserved for usage in the western and southern part of New Jersey while Region D is reserved for the eastern portion of New Jersey. To obtain information on which counties fall under Region C or Region D, as well as to download these rainfall distributions, please visit: https://www.nrcs.usda.gov/wps/portal/nrcs/main/nj/technical/engineering.

Type of Unit Hydrograph

A hydrograph is a plot of flow rate versus time at a specific point in a watercourse. A unit hydrograph is a hydrograph resulting from one inch of excess precipitation generated uniformly throughout a watershed at a uniform rate over a specified period of time. Historically, the Standard unit hydrograph (more commonly known as the 484 unit hydrograph) has been utilized when calculating flow rates in New Jersey. In recent years, a second unit hydrograph, called the DelMarVa unit hydrograph, has been utilized in specific cases in portions of New Jersey located in the Coastal Plain. With all other factors being equal, both unit hydrographs compute the same volume of runoff for any given storm event. However, the Standard unit hydrograph produces a higher peak flow rate than the DelMarVa unit hydrograph.

NRCS only applies the DelMarVa unit hydrograph to watersheds in the Coastal Plain that are characterized by flat topography, low relief, and significant surface storage. Under the Stormwater Management Rules at N.J.A.C. 7:8, the DelMarVa unit hydrograph should be used where these criteria are met because the Standard unit hydrograph overestimates the peak flow rate of runoff in the existing condition, leading to excessive peak flow rates in the proposed condition, which could exacerbate offsite flooding.

However, under the FHACA Rules, in keeping with the factors of safety referenced in N.J.A.C. 7:13-1.2 and in this manual, the DelMarVa unit hydrograph should not be used for any flood hazard area calculations in most cases. While there may be areas where the underlying assumptions of the DelMarVa unit hydrograph apply in the existing condition, due to development potential of those areas and continued urbanization, the underlying assumptions of the DelMarVa unit hydrograph would no longer apply, and flood levels would be underestimated. As a result, new construction would be at additional flood risk. Therefore, to better protect against the possibility of adverse flooding impacts as a watershed is developed, the Department strongly recommends the use of only the Standard unit hydrograph for flood hazard calculations.

Should an applicant believe special circumstances apply to a project that would justify the use of the DelMarVa unit hydrograph, they should contact the Department prior to performing any calculations. The Department may consider usage of this hydrograph on a case-by-case basis, but this is not guaranteed and should not, therefore, be assumed.

4.5.3 Other Methods of Calculation

While the NRCS methodology is the most common and the recommended technique to calculate peak flow rates and hydrographs, other methodologies exist, including USGS's Special Report 38, USGS's StreamStats program, and the Rational Method, each of which is discussed below.

These methodologies are not recommended in most situations although they were employed in certain cases in the past for a variety of reasons. Should an applicant need to verify a flood hazard area but the prior calculations were based on one of these methodologies, The Department recommends the applicant revise those calculations in favor of NRCS methodology unless they can first demonstrate to the Department's satisfaction that the basis for the old calculations is still valid.

USGS's Special Report 38

While it was utilized years ago, Special Report 38 (SR38) is considered to be obsolete because the data sets that support it are outdated. As such, the peak flow rates calculated by SR38 are not accurate, and the Department strongly discourages its use.

USGS's StreamStats

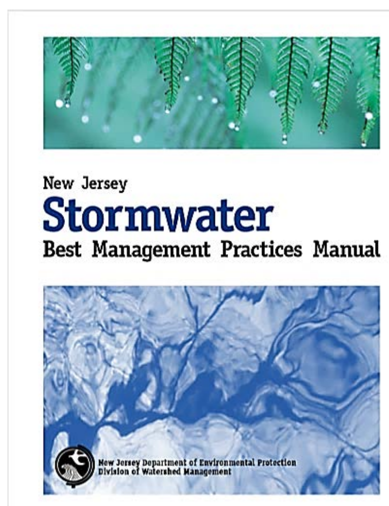
StreamStats is a computer program with the ability to estimate peak flow rates for each of the 2, 5, 10, 25, 50, 100, and 500-year storms in ungaged and non-tidal watercourses. However, the Department does not currently recommend the use of StreamStats for flood hazard calculations because NRCS methodology provides a more rigorous calculation of peak flow rates and calculates an entire hydrograph, which is essential for analysis when offsite flooding impacts become a concern. Additionally, according to the NRCS, regression equations (utilized by StreamStats) are best suited for a watershed where changes are not expected in the hydrologic conditions that existed at the time that stream flow measurements were taken. Because urbanization of watersheds alters the hydrologic conditions over time, StreamStats may not be best suited to forecast peak flow rates over time.

However, the Department may consider the use of StreamStats on a case-by-case basis if an applicant believes its use is appropriate for a particular watercourse along a site. The applicant is strongly urged to contact the Department prior to performing any calculations. The Department's acceptance of the use of StreamStats is not guaranteed and should not, therefore, be assumed.

The Rational Method

The Rational Method is generally considered to be an overly simplified computation since it associates runoff as a percentage of rainfall without accounting for hydrologic losses that occur prior to the start of runoff. Therefore, it does not adequately consider the physical variables that play a role in how runoff is generated.

Also, this method is generally limited by drainage area. The Department's Stormwater Best Management Practices (BMP) Manual, which is a companion document to the Stormwater Management Rules at N.J.A.C. 7:8, has restricted the use of the Rational Method to watersheds less than 25 acres in size. Similarly, the NRCS recommends limiting drainage areas to less than 50 acres when the Rational Method is proposed. While other publications suggest somewhat higher drainage area limits, the Rational Method and its companion, the Modified Rational Method, are not recommended to determine flood hazard area limits due to these issues and because better computational techniques are available.



4.5.4 Attenuation of Peak Flow Rates

Peak flow rate *attenuation*, which is a reduction in the peak of a hydrograph, may result from natural features in a watercourse or from manmade obstructions. A discussion of the potential causes of attenuation is provided below.

For the purposes of the FHACA Rules, the Department has found that modeling such attenuation when calculating peak flow rates to establish the flood hazard design flood elevation is not appropriate in most cases because attenuation may not be achieved in the field, at least not to the degree calculated theoretically. Also, the November 2016 edition of FEMA's *Guidance for Flood Risk Analysis and Mapping, Floodway Analysis and Mapping* explains that if storage areas behind structures are accounted for in peak flow rate calculations, floodway encroachment analyses cannot be performed in those areas. In these cases, FEMA will assume the floodway limits are equal to the floodplain boundaries where the storage area exists.

However, an applicant may incorporate attenuation into peak flow rate calculations in certain circumstances. Prior to performing such calculations, the applicant should verify with the Department that accounting for attenuation is acceptable. A discussion of when and how to account for attenuation is also provided below.

Causes of Attenuation

Peak flow rate attenuation may result from a number of factors, including the following:

- Hydraulically inadequate bridge or culvert crossings
  - These structures may not remain intact during a given flood event, and if either the structure or its embankments fail, the hydraulic control will be lost and the theoretical attenuation will not be achieved. Any proposed buildings or other structures to be constructed downstream of inadequate bridges or culverts would be at a greater and unnecessary risk of flood damage during flood events even where calculations incorporating theoretical attenuation indicate otherwise. Therefore, use of attenuation at inadequate bridges and culverts is at the discretion of the Department. The applicant is strongly urged to contact the Department prior to undertaking any hydrologic calculation for the purpose of verifying a flood hazard area that includes attenuation due to the presence of inadequate bridges or culverts.

- Storage via dams, lakes, and ponds
  - Dams, lakes, and ponds offer some degree of storage. However, because these areas already store water statically, they may not necessarily be able to store much in the way of incoming floodwaters. For this reason, it is best to contact the Department prior to considering attenuation from these sources.

- The presence of depressions within a drainage area
  - Depression areas (which can be either natural depressions in a landscape or can form inadvertently as a result of nearby construction and grading activities) may have the ability to store runoff prior to contributing flow to a downstream point of interest. However, considering attenuation from depressions with a drainage area is not appropriate for the purposes of the FHACA Rules because the storage area may not continue to exist in the future. Even if it is located in a flood hazard area, should such an area be removed, any compensation that is provided may not necessarily function in precisely the same manner as the existing storage area. For similar reasons, it is not appropriate to utilize the swamp and ponding factor in NRCS methodology (discussed in Section 4.5.2) to attenuate peak flow rates.

- Natural attenuation as stream flow or flood flow travels in a downstream direction
  - Natural attenuation may occur as part of normal stream flow. A reach routing can be conducted to attenuate some of this flow. However, due to the extensive amount of surveying required to perform such a reach routing, assuming natural attenuation may not be practical. The Department should be contacted prior to attempting a reach routing.

- Engineered detention facilities
  - Given the relatively small drainage area serviced by detention facilities, in comparison to the much larger drainage area of a regulated water, a detention basin may attenuate flow from a site much earlier than the peak flood of the regulated water would occur. Therefore, subtracting attenuated flow due to detention facilities from the overall peak flow for a regulated water can underestimate the true peak flow rate and as such, is typically not accepted by the Department for a flood hazard event or other large storm events. In addition, facilities such as detention basins do not address the additional volume of runoff that enters a regulated water.

When and How to Account for Attenuation

While the Department generally discourages attenuation for the purposes of establishing the flood hazard area, flood routings may sometimes be required at inadequate structures to accurately assess the relative hydraulic differences between existing and proposed conditions. For example, an applicant may propose to replace a culvert with a structure that is more hydraulically efficient (such as a structure with a larger area open to flood flows), which may result in significant decreases in flood elevations upstream of that structure. In such a case, the Department is concerned with additional flooding that may occur downstream of the proposed structure. If no routing is performed, the extent to which the larger opening increases the peak flow rate through the structure cannot be evaluated, and without this information, the flooding impact from the replacement of the culvert cannot be calculated.

If consideration of attenuation is required for this purpose or if a design professional chooses to account for attenuating influences on flood flows in other circumstances with the Department's approval, as-built topography of the attenuating features with appropriate hydrologic routings must be provided to demonstrate exactly how they reduce peak flow rates. In addition, a steady flow standard step analysis with a level pool routing is typically necessary to account for these losses. In the case of a culvert replacement or similar project where the relative difference between existing and proposed conditions is important, the routing should be performed for both the existing and proposed conditions to enable comparison of the hydraulic impacts associated with both the existing and proposed structures. The flow rate obtained via the level pool routing would then be entered back into the standard step analysis to show the relative difference in the downstream direction. Alternatively, an unsteady flow model may be used.

For more information concerning attenuation with relation to bridges and culverts, please refer to Section 10.3.3.

4.6 Establishing Flood Elevations

Once the desired flow rates are calculated along a watercourse, as explained in Section 4.5, Step 2 of Method 6 requires a hydraulic analysis to determine flood elevations at the site in question (see Section 4.4.4). A hydraulic analysis is also necessary for projects in which a design engineer must determine the difference in flood elevations between existing and proposed conditions. Such projects may include the construction or reconstruction of bridges or culverts (see Section 10), channel modifications (see Section 13.1), and other projects that would alter the hydraulic capacity of the channel or floodway. Section 4.8.2 explains how to report hydraulic calculations to the Department.

As was the case for flow rates, the regulatory flood elevation may be determined from published data, such as Department delineations or FEMA mapping (see Section 4.4.1 and Section 4.4.2, respectively, for information on how to determine the regulatory flood elevation from these sources). Alternatively, calculations may be performed via the following methodologies:

- **Manning's Equation (see Section 4.6.1)**
- **HDS-5 (see Section 4.6.2)**
- **HEC-RAS (see Section 4.6.3)**

This manual does not seek to provide a detailed explanation of the methodologies used in various hydraulic models but instead aims to highlight some necessary considerations and requirements.

4.6.1 Manning's Equation

Manning's equation may be used to compute flood limits in the absence of a published flood delineation, albeit under limited circumstances. The regulated water in question must have a uniform channel shape, slope, and roughness, and there must not be any backwater due to a downstream obstruction or tailwater. When a channel meets these criteria, the flow depth is said be at normal depth. In other words, the slope of the energy grade line is parallel to the slope of the channel. In many cases, these conditions cannot be achieved in natural open channels, and therefore, Manning's equation cannot be used to calculate the flood depths along a reach of the watercourse. Manning's equation is more widely used to estimate the starting water surface elevation for other types of detailed hydraulic analyses, such as the standard step backwater analysis.

Manning's equation is as follows:

$$Q = VA = \left(\frac{1.49}{n}\right) A R^{\frac{2}{3}} \sqrt{S}$$

Where:
Q = Flow Rate, (ft^3/s)
v = Velocity, (ft/s)
A = Flow Area, (ft^2)
n = Manning's Roughness Coefficier
R = Hydraulic Radius, (ft)
S = Channel Slope, (ft/ft)

In this equation, the hydraulic radius is calculated as the area of flow divided by the wetted perimeter. Once the flow rate is calculated by other means, as described in Section 4.5 of this manual, the flood depth can be calculated given the channel geometry, slope, and roughness by rearranging the area and hydraulic radius terms in terms of channel width and depth and then using an iterative solution to estimate the flood depth. Further discussion and illustration of the proper use of this equation can be found in *Open-Channel Hydraulics* by Ven Te Chow.

4.6.2 Hydraulic Design Series No. 5

Another method for calculating flood elevations is Hydraulic Design Series No. 5 (HDS-5), *Hydraulic Design of Highway Culverts*, which is published by the US Department of Transportation, Federal Highway Administration and available at https://www.fhwa.dot.gov/. This publication combines the information and methodology contained in Hydraulic Engineering Circular No. 5, "Hydraulic Charts for the Selection of Highway Culverts," and other more recent information developed by governmental agencies, universities, and culvert manufacturers to produce a comprehensive culvert design publication.

When using HDS-5, the design engineer must analyze the bridge or culvert under both inlet and outlet control to properly determine the flood elevation at that bridge or culvert. The higher computed elevation determines the hydraulic control under which the bridge or culvert operates and also determines the flood elevation.

However, the use of this method for determining the flood hazard elevation is limited because it only provides the flood hazard elevation at the face of an existing bridge or culvert. If flood elevations are also required elsewhere, another calculation method will be necessary. As a result, this methodology is more useful in determining the change in upstream water surface elevations when replacing a bridge or culvert. However, like Manning's equation, HDS-5 may be used to determine starting water surface elevations for other hydraulic analyses. For more information on the use of this methodology in relation to bridges and culverts, please see Section 10.3.3 of this manual.

4.6.3 HEC-RAS Computer Program

The most common hydraulic analysis received by the Department for the purposes of the FHACA Rules is the standard step backwater analysis as executed through HEC-RAS, which is available for download at http://www.hec.usace.army.mil/software/hec-ras/downloads.aspx. This program was developed by the Hydrologic Engineering Center (HEC), Army Corps of Engineers, California District to calculate water surface elevations in natural and manmade channels under subcritical, supercritical, and mixed flow conditions. It allows for consideration of the effects of tailwater, changes in channel and overbank shape, slope, and roughness, and hydraulic structures, such as bridges, culverts, weirs, embankments, and dams.

The accuracy of a HEC-RAS model will reflect not only the accuracy of the input data but also the level of effort devoted to the development of the model. Both the input and output data must be reviewed by the Department to ensure that the results returned by the model are reasonable. Therefore, the Department recommends full understanding of the assumptions, data requirements, capabilities, methodologies, and limitations of both the software and the hydraulic theory behind the software prior to using HEC-RAS. Such information, including the HEC-RAS User's Manual, is available at http://www.hec.usace.army.mil/software/hec-ras. In addition, discussions of some of the data collection considerations and important input variables are provided below.

It is important to note that the vast majority of HEC-RAS-based hydraulic analyses that are accepted by the Department rely on steady flow computations. The use of unsteady flow models for the purposes of establishing flood hazard limits is not typically allowed under the FHACA Rules because these models include storage areas that serve to attenuate peak flow rates, the sustained existence of which is uncertain as mentioned in Section 4.5.4. An unsteady flow analysis will only be accepted to establish the flood hazard area design flood elevation if an applicant can satisfy the Department that it is appropriate. However, unsteady flow analyses are more generally accepted for bridge and culvert replacement projects because the primary hydraulic concern is the relative impact of a proposed structure, as opposed to the absolute flood elevation. For bridge or culvert replacements, analysis of existing storage areas becomes crucial, in part because any loss of storage associated with a more hydraulically efficient proposed structure must be accounted for accurately in the design so that existing structures downstream of the existing bridge or culvert do not inadvertently become subject to additional flooding as a result of the replacement structure, which is prohibited under N.J.A.C. 7:13-12.7. A more detailed discussion of this is provided in Section 10.3.3.

Data Collection Considerations

Prior to building a HEC-RAS model, certain data must be collected. Important considerations concerning data collection for a HEC-RAS analysis include the study reach, field surveyed cross-sections, and drainage area irregularities, each of which is discussed in detail below.

The Study Reach

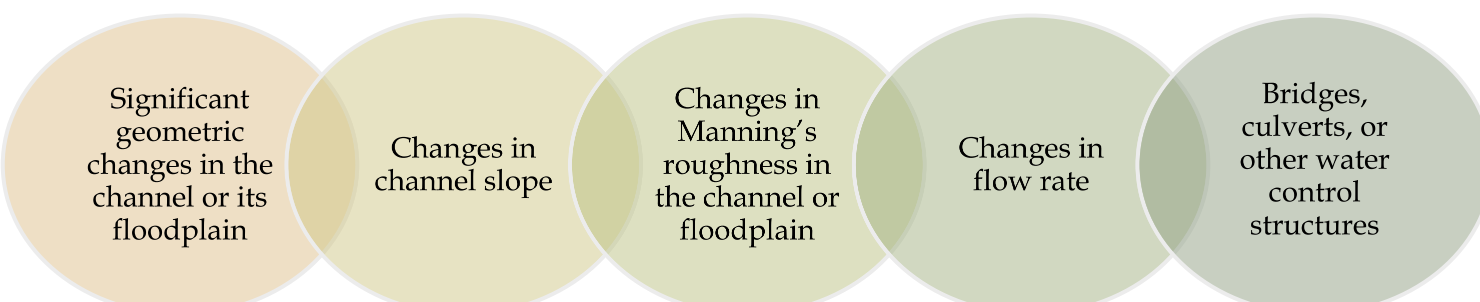
To establish flood elevations along a watercourse using HEC-RAS, the limits of the study area must first be defined. Flood studies must typically extend at least 500 feet upstream and downstream of the property limits because a starting water surface elevation is usually only an estimation, which can introduce error into the computations. By extending the study area to 500 feet offsite, the effects of any inaccuracies in starting water surface elevation are dampened by the time the standard step calculation is made on site. Should the applicant believe that a shorter reach is sufficient, a consultation with Division of Land Use Regulation staff engineers is strongly recommended prior to submitting an application.

In some situations, study reaches longer than 500 feet offsite are required. For example, a structure located more than 500 feet downstream of the site may cause backwater that impacts flood elevations at the project site. In this case, the study reach must be extended in the downstream direction to analyze the impact of those conditions. Another example is a bridge or culvert replacement that causes decreases in upstream water surface elevations. In this case, the HEC-RAS model must be extended upstream to where the existing and proposed flood profiles converge for every flood event analyzed to accurately determine downstream impacts. Please note that the study reach must be at least 500 feet even if the existing and proposed flood profiles converge less than 500 feet from the site for every flood event analyzed.

Cross-Sections

Once the study reach is defined, a hydraulic analysis requires that field-surveyed cross-sections be obtained. These cross-sections will represent the watercourse and its floodplains associated with various flood events (e.g., 2, 10, 25, 50, and 100-year storms), the flood hazard area, and the floodway.

In general, cross-sections must be placed where there are:



By convention, HEC-RAS cross-sections are taken looking in the downstream direction, not the upstream direction. However, engineering judgment and HEC-RAS modeling experience must be used in determining how cross-sections should be oriented, the number and location of the cross-sections, and the amount of space between each cross-section.

Cross-sections should span the entire flood hazard area. However, in cases where the flood hazard area is significantly wider than the channel itself, such that obtaining field-surveyed cross-sections is not feasible, the field-surveyed cross-sections may be supplemented with other data sources, such as LiDAR data, provided that:

- The Department agrees that the use of the data source is an acceptable substitute for a more extensive field survey.
- The data provided by the source is in agreement with the field-surveyed topography and is verified as accurate.

In these situations, the applicant should contact Division of Land Use Regulation staff engineers to avoid unnecessary delays in the permitting process.

Where the floodway location must be calculated, field-surveyed cross-sections must encompass the entirety of the 100-year floodplain at minimum. Due to development restrictions in the floodway under the FHACA Rules, field-surveyed cross-sections spanning the entire 100-year floodplain are necessary to ensure the calculated floodway location is accurate so that the floodway width is not underestimated.

Cross-sections must always be taken perpendicularly to the direction of flow for each flood analyzed. As a result, they may not intersect because each cross section represents flow at a separate location in the floodplain and flood hazard area.

Drainage Area Irregularities

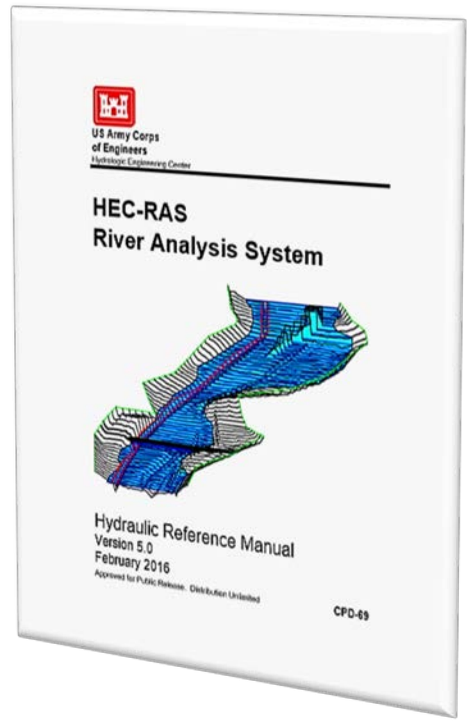
Occasionally, the size of a watercourse's drainage area may drop below the 50-acre threshold on a given site or within a hydraulic study area. While the portion of a watercourse that has a drainage area of less than 50 acres does not have a regulatory flood hazard area, this portion must still be included in the HEC-RAS analysis if it lies within the study area. Otherwise, the Department will not be able to verify the accuracy of the flood limits calculated by the HEC-RAS model. Section 2.1.3 of this manual provides an explanation of how to determine the drainage area.

Important Input Variables

Once data is collected, as described above, the HEC-RAS model may be built. Several important input variables are required for an accurate HEC-RAS analysis, including energy loss coefficients, flow regime, and boundary conditions, all of which are discussed in detail below.

Energy Loss Coefficients

Several sets of energy loss coefficients must be considered when inputting data into the HEC-RAS program, including the Manning's roughness coefficient, also known as Manning's n value. This is a measure of surface roughness, which contributes to the efficiency (or lack thereof) of a channel or floodplain to convey floodwaters. It is a measure of the resistance to flow and is highly dependent on the type of land cover within the channel and its overbank (floodplain). An acceptable reference for Manning's roughness coefficients is found in Ven Te Chow's book, *Open Channel Hydraulics*. Excerpts from this book are found in a variety of other reference materials, including the Hydrologic Engineering Center's *Hydraulic Reference Manual*, available at http://www.hec.usace.army.mil/SOFTWARE/hec-ras/documentation/HEC-RAS%205.0%20Reference%20Manual.pdf.



Another set of energy loss coefficients is the contraction and expansion coefficients. Flow may expand and/or contract due to changes in the geometry (flow area) between adjacent cross-sections. Such losses occur due to the changing shape of the channel and/or its overbank areas and the presence of obstructions in these areas, such as bridges and culverts. The energy loss from short abrupt transitions are larger than losses from gradual transitions. Recommended contraction and expansion loss coefficients are contained in the both the *HEC-RAS User's Manual* and in the *Hydraulic Reference Manual*.

Contraction and expansion coefficients must be used consistently throughout the entirety of the HEC-RAS model. For example, coefficients used to reflect changes in flow area and transition length between different cross-sections in one portion of a model must be applied in all other portions of the model where similar changes in flow area are encountered. In other words, changes that are considered mild or abrupt between two cross-sections should be modeled with the appropriate coefficients, and those same coefficients should also be used where similar changes exist between other cross-sections. For example, the contraction and expansion coefficients obviously need to be adjusted to reflect a more abrupt loss from the presence of bridges or culverts, but these coefficients must also be adjusted in all other portions of the model where changes are abrupt, even if those changes are not caused by the presence of a bridge or culvert.

Similarly, selection of contraction and expansion coefficients used in models that describe the difference between existing and proposed conditions should also be consistently applied. For example, if a proposed project will increase or reduce the severity of the flow transition between two cross-sections in an existing condition model, the proposed model should reflect this change with appropriately modified coefficients. Applying coefficients inconsistently can negatively impact the accuracy of the HEC-RAS model.

Flow Regime

The selection of flow regime is another important consideration for any HEC-RAS model. Typically, HEC-RAS models assume subcritical flow. However, if the model reports several warning messages relating to critical depth, either additional cross-sections are required to address the warnings or the system should be modeled with a mixed flow regime because the watercourse is not entirely under subcritical control throughout the study length. Additionally, if the regulated water is steep or there is relatively little resistance to flow, it may be best to utilize a supercritical flow regime.

Boundary Conditions

Boundary conditions include the starting water surface elevation in a HEC-RAS model. Published data may be used if the flood elevation is known. Otherwise, normal depth (via Manning's equation as described in Section 4.6.1) or critical depth (the depth of flow where energy is at a minimum for a particular discharge) may be used where appropriate.

When starting water surface elevations are known along a regulated water, it is common practice to use those known values, but this may not be appropriate in certain cases. Engineering judgment must be exercised when selecting an appropriate starting water surface elevation, particularly in the following cases:

A bridge or culvert replacement where a backwater condition exists from another watercourse

Using a known starting water surface elevation associated with a downstream, larger regulated water may not be appropriate in this situation, even if that larger water is located in the study area of the water in question. The watercourses may have floods that peak at different times, and using a starting water surface elevation based on a known peak from the downstream watercourse would mask the hydraulic impact of the proposed bridge or culvert. In such a case, it may be more appropriate to use normal depth as a starting water surface elevation. However, this is tempered by the elevation of backwater that may be likely when the water in question experiences its peak flood events. In situations like this, engineering judgement is crucial, and it is best to consult with Division of Land Use Regulation staff if there is any question concerning the selected starting water surface elevation.

A tributary to a tidal water

Using the flood elevation from a parent tidal water as a starting water surface elevation for one of its tributaries may not be appropriate. FEMA suggests that using a smaller storm may be more appropriate. To determine the 100-year flood elevation of the tributary, it may be appropriate to use the elevation of the mean higher high water line. Consulting with a Division of Land Use Regulation engineer is recommended for determining the most appropriate starting water surface elevation in this situation.

4.7 Floodway Calculations (Encroachment Runs)

As mentioned previously, the floodway is defined as the portion of the flood hazard area that is required to convey floodwaters resulting from the 100-year flood. At a minimum, the floodway contains the channel, but it routinely extends beyond the channel limits and may encompass the entire 100-year floodplain or even the entire flood hazard area. While the maximum width of a floodway is the width of the entire flood hazard area, the minimum width is the distance between the banks of the channel. The floodway cannot be any narrower than the width between the channel banks (meaning it cannot be located within the channel banks) because the hydraulic function of both the channel banks and the floodway is to convey floodwaters. In most cases, the floodway is located somewhere between the channel banks and the limits of the 100-year floodplain, and its exact location cannot be determined without calculations.

Because of its function to convey floodwaters, N.J.A.C. 7:13-11.3 strictly limits the placement of fill and structures in the floodway, which can alter the floodway's conveyance pattern and capacity, resulting in additional flooding and erosion potential. Therefore, knowledge of the floodway limits is often required to determine compliance with the FHACA Rules.

> **FLOODWAY**
> The portion of the flood hazard area that is required to convey floodwaters resulting from the 100-year flood.

As described in the discussions of Method 4 (see Section 4.4.2) and Method 6 (see Section 4.4.4), determining the limits of a floodway requires that 100-year flood elevations be computed based on a standard step backwater analysis. As per N.J.A.C. 7:13-3.4 and N.J.A.C. 7:13-3.6, floodway limits must normally be calculated assuming equal conveyance reduction on both sides of the watercourse with a maximum rise in the 100-year water surface elevation of 0.2 feet. In other words, to determine the floodway, the conveyance must be reduced equally from both sides of the watercourse, and the encroachment cannot increase the 100-year water surface elevations more than 0.2 feet at any cross-section. This applies whether an applicant owns property on one side of a regulated water or both sides of a regulated water.

If floodway calculations indicate a decrease in water surface elevations, the entire flood hazard area will be considered floodway in all cross-sections where the calculated decrease occurs to prevent the floodway from becoming too narrow from a regulatory perspective (see N.J.A.C. 7:13-3.6(c)1(iii)2). Altering other components of the energy equation to compensate for the change in water surface elevation is not permitted under the FHACA Rules. Note that FEMA also does not allow decreases in water surface elevations in computing floodway limits.

HEC-RAS (see Section 4.6.3) is the most common model used to determine the limits of the floodway, and it includes five different methods for computing the floodway, referred to here as Encroachment Methods 1 through 5 (not to be confused with Methods 1 through 6 discussed earlier).

Encroachment Method 1	The location of the floodway is specified by the modeler.
Encroachment Method 2	The location of the floodway is based upon a fixed top width. The floodway limits are made an equal distance from the channel.
Encroachment Method 3	The floodway is calculated as a specified reduction in conveyance.
Encroachment Method 4	The floodway is calculated with a targeted increase in water surface elevation.
Encroachment Method 5	The floodway is calculated with a targeted increase in water surface elevation, but if the target cannot be met, the floodway is then calculated based on a targeted increase in energy.

However, because the FHACA Rules base a floodway calculation only on a targeted water surface elevation increase and lack a surrogate standard, Encroachment Method 4 must be used. When using HEC-RAS to model the floodway, equal conveyance must be selected and set to "true," the floodway must be based on the 100-year peak flow rate, and a target water surface elevation increase of 0.2 feet must be specified at each cross-section in the analysis, as required by N.J.A.C. 7:13-3.4 and N.J.A.C. 7:13-3.6. The starting water surface elevation must also be increased by 0.2 feet.

When the program conducts the analysis, the modeler must ensure that the program was successful in achieving an increase in water surface elevation no greater than 0.2 feet. Specifying a target increase of 0.2 feet does not mean that the HEC-RAS program will successfully meet that target. In many cases, HEC-RAS will exceed the target, which is not permitted by N.J.A.C. 7:13-3.4 or N.J.A.C. 7:13-3.6. Since Encroachment Method 5 cannot be used when the target water surface elevation is not achieved, the modeler needs to change the target water surface elevations to amounts less than 0.2

feet and rerun the program to ensure the achieved increase in water surface elevation is less than 0.2 feet.

When conducting a floodway analysis, the modeler must also verify that HEC-RAS did not return a decrease in water surface elevation when the encroachment analysis is performed. This is known as a negative surcharge, and it is not permitted under the FHACA Rules. If this occurs, the entire extent of the flood hazard area in any cross-section associated with a negative surcharge must be considered part of the floodway, as required by N.J.A.C. 7:13-3.4 and N.J.A.C. 7:13-3.6.

It is also important to note how far each cross-section extends into the overbank when conducting a floodway analysis. When determining the limits of the flood hazard area, the surveyed cross-section might not always extend far enough to contain the entire flood hazard area. If no additional data is obtained, the HEC-RAS program will vertically extend the ends of the cross-section until a flood elevation is computed. While this may be conservative and can be accepted in certain circumstances for determining only the flood hazard elevation, it is neither conservative nor acceptable for determining the limits of the floodway because the floodway encroachment calculation begins at the limit of the 100-year floodplain. Therefore, if the cross-section does not extend to the limits of the 100-year floodplain, HEC-RAS will begin encroachment calculations closer to the channel than it should, which will result in a narrower floodway than is realistic for the 100-year flow rate. In situations where the calculated 100-year water surface elevation is higher than all points in a given cross-section, the applicant must obtain additional field-surveyed cross-sectional data until each cross-section in the analysis spans the entire extent of the 100-year floodplain.

Sometimes, design engineers may wish to smooth or straighten a floodway limit that was calculated using equal conveyance to optimize the location of a floodway on a given site. In such cases, the engineer must submit the computations and drawings showing the location of the equal conveyance floodway (Encroachment Method 4) as well as the calculations and drawings showing the optimized floodway to enable the Department to evaluate the extent to which the design engineer proposes to adjust the floodway line. Note that the approval of an optimized floodway line is at the discretion of the Department. An applicant should not assume that an adjusted floodway limit will be approved.

When the computed water surface elevation is below critical depth, supercritical flow exists. For supercritical flow profiles, there should be no further encroachments to establish the floodway. In such cases, the floodway should be set at the limits of the critical or supercritical 100-year flood limits.

4.8 Engineering Report and Drawing Requirements

As mentioned in Section 3.3.2 of this manual, an engineering report must be submitted to the Department when a project requires hydrologic and hydraulic calculations. Hydrologic and hydraulic calculations are typically required when a flood hazard area verification is requested (using Method 4 or 6) or when in-watercourse activities are proposed, such as bridges, culverts, dams, stream stabilization and restoration projects, and flood control projects. Engineering drawings must accompany these reports. Section 4.8.1 provides a description of the report and drawing requirements where hydrologic calculations are required, and Section 4.8.2 provides a description of the report and drawing requirements where hydraulic calculations are required.

4.8.1 Hydrology Reporting and Drawing Requirements

The type of hydrologic information required is dependent upon the source of information used. Different requirements apply when using a Department delineation under Method 1 (see Section 4.4.1), FEMA studies under Method 3 or Method 4 (see Section 4.4.2), and calculation studies under Method 6 (see Section 4.4.4).

In general, where published studies exist, the applicant may usually rely on those studies without having to present hydrologic calculations to the Department for review. The submission requirements for hydrologic information based on a Department delineation and/or FEMA studies are discussed below.

Where published studies do not exist, calculation studies (Method 6) are required. The submission requirements for calculation studies are also provided below. Calculations are also required in circumstances where published studies exist but do not provide enough information, such as where a routing is required for a hydraulic modification of a regulated water through a bridge or culvert replacement because a hydraulic analysis shows a decrease in water surface elevation upstream of the bridge or culvert. To perform a routing, such as the level pool (Modified Puls) routing, an entire hydrograph is required, which is not included in information published by the Department or by FEMA. These sources only include peak flow rates. In such a case, the applicant must perform hydrologic calculations to create a hydrograph that can be routed, and the submission requirements are similar to that for a Method 6 computation, as discussed below.

Department Delineation

Where a Department delineation (Method 1) is utilized, calculations supporting the derivation of the peak flow rates are not required. Instead, the applicant must submit a copy of the relevant portion of the Department delineation that shows the peak flow rates for the relevant portion of the regulated water in question. In few instances, this information is available on the plan view of the mapping associated with the Department delineation, but in most cases, the applicant will need to obtain paper copies of the hydraulic calculations upon which the mapping was based. This information may be obtained through the address and phone number listed in Section 4.4.1 of this manual.

FEMA Studies

Where FEMA mapping is utilized (Methods 3 and 4), peak flow rate data may be referenced instead of calculated. The applicant must submit a copy of the relevant pages from the Flood Insurance Study that detail the peak flow rates for the relevant portion of the regulated water in question. Obtaining peak flow rate data for Method 2 in unnecessary since this method pertains only to flood hazard areas that are controlled by the Atlantic Ocean.

Calculation Studies (Method 6)

Where Method 6 is utilized, information pertinent to the derivation of the peak flow rate and corresponding hydrograph must be submitted, including all of the following:

- A signed and sealed topographic map (or multiple maps to maintain clarity) showing:
  - The boundaries of the drainage area
  - The time of concentration flow path within the drainage area, marking each segment of sheet flow, shallow concentrated flow, and open channel flow
  - An overlay of the soils types within the drainage area
- A tabulation of the different land covers within the drainage area (in acres)
- A computation showing the calculated composite curve number for the drainage area
- A computation showing the calculated time of concentration, including each of the sheet flow, shallow concentrated flow, and open channel flow segments
- Precipitation amount in inches
- Unit hydrograph used
- Antecedent moisture condition
- Rainfall distribution

Proprietary programs used to generate hydrographs and to calculate peak flow rates readily provide this information in the reports they generate.

All information must be included in the engineering report signed and sealed by an engineer licensed to practice in New Jersey, including all model input and output. Output data includes summary tables depicting the peak flow rate for each hydrograph generated as well as a graphical representation of the computed hydrograph. In most cases, it is not necessary to provide a print out of the entire hydrograph. The only exception is when routing procedures are performed. Examples include the analysis of proposed detention systems under the Stormwater Management Rules at N.J.A.C. 7:8 and routings performed at bridges and culverts for both the existing and proposed conditions.

4.8.2 Hydraulic Reporting and Drawing Requirements

For any hydraulic calculation, the engineering report must contain a list of all assumptions used to construct the hydraulic model. First, the report must identify the suitability of the selected hydraulic method (e.g., Manning's equation, standard step method, etc.). Input and output data must also be submitted in a legible format. The type of data and the specific format will depend on the method used. The reporting requirements for Manning's equation, HDS-5, and HEC-RAS are all provided below.

Manning's Equation

When Manning's equation is used to calculate a water surface elevation, all of the following information must be submitted:

- ✓ The peak flow rate used in the calculation
- ✓ Signed and sealed cross-sections for the reach of regulated water through which Manning's equation is being applied (each cross-section must depict the calculated flood elevation)
- ✓ A scaled topographic map that includes the location, orientation, and extent of each cross-section analyzed
- ✓ A calculation of the slope between cross-sections
- ✓ Photographs of the channel and overbank areas to support the selection of the Manning's n value at each cross-section.
- ✓ A calculation of the flow area and wetted perimeter corresponding to the peak flow rate of interest

HDS-5

When HDS-5 is used to calculate a water surface elevation upstream of a bridge or culvert, all of the following information must be submitted:

- ✓ The peak flow rate used in the calculation

- ✓ The downstream cross-section
- ✓ Photographs of the downstream cross-section to verify the selection of the Manning's n value
- ✓ A cross-section of the roadway over the culvert, used to define any weir flow
- ✓ A cross-section of the culvert, including its size, shape, dimensions, and Manning's n value
- ✓ Photographs showing the inlet configuration (square edge with headwall, end projecting from fill, etc.)
- ✓ Model output indicating the calculated flood elevations and control type (inlet or outlet)

HEC-RAS

When HEC-RAS is used, all of the following information must be submitted:

1. Photographs at each cross-section documenting the land cover in the channel, left overbank, and right overbank to support the selection of the Manning's n value in these areas
2. Signed and sealed cross-sections plotted on engineering drawings with all cross-section drawn looking downstream and the channel and immediate overbank areas field surveyed
3. A topographic plan showing location, orientation, and lateral extent of each cross-section
4. A plan view of the calculated flood hazard limits
5. Where the floodway limits are calculated, the limits of the floodway shown in plan view and the left and right encroachment stations shown on each cross-section
6. Input data used in the HEC-RAS analysis, including flow rates, starting water surface elevations, flow regime, geometric data (e.g., station, elevation, bank station location, Manning's n values at each cross section), reach lengths between cross-sections, contraction and expansion coefficients, ineffective flow areas, levees, and/or blocked obstructions
7. Output data calculated by HEC-RAS, including summary output tables (typically Standard Table 1), detailed output tables, and the summary of warnings, errors, and notes
8. An electronic version of the HEC-RAS files

HEC-RAS can generate a report that easily produces the above listed information. The report is generally saved as a text document that word processors can open. When word processors are utilized, the applicant must make sure that the HEC-RAS report is organized legibly to facilitate review.

In addition to the report generated by HEC-RAS, the applicant must also create and submit a narrative report that explains each of the assumptions made by the modeler in preparing the report. This includes justification for the selected flow regime (subcritical flow, supercritical flow, or mixed flow) utilized in the model and justification for any deviations from any of the criteria presented in this manual, the HEC-RAS User's Manual, or the HEC-RAS Hydraulic Reference Manual. If the Department determines that these justifications are not sufficient, the applicant will have to revise the submitted HEC-RAS model.

As noted above, the warning notes and messages generated by the HEC-RAS model must be submitted. The applicant must also explain why the warning messages do not invalidate the results of the model and document the steps that were taken to resolve the warning messages. The Department may require further revisions to the model based on these warning messages.

HEC-RAS will provide computer-generated cross-sections showing the computed water surface elevations and energy grade lines, and it will also generate a longitudinal stream profile. These must be submitted with the HEC-RAS generated report.

When routings are performed, all of the following information is also required:

- ✓ The inflow hydrographs along with the dimensions of the feature through which flow is being routed (e.g., bridge or culvert and road profile)
- ✓ The corresponding outflow hydrographs
- ✓ Stage-storage and stage-discharge charts generated by the hydrologic program for the existing and proposed conditions
- ✓ The HEC-RAS analysis showing the change in flow rate downstream of the structure through which flow is being routed for both the existing and proposed conditions
- ✓ Signed and sealed, legibly scaled drawings of the storage area behind the structure through which flow is being routed for both the existing and proposed conditions
- ✓ Existing and proposed dimensions of the structure through which flow is being routed (which would include the existing and proposed bridge or culvert, including the elevation of the associated roadway, typically presented in the general plan and elevation drawings)

The information pertinent for any routing must be included in the signed and sealed engineering report, which must contain a detailed narrative explaining all assumptions made.

SECTION 5
FLOOD STORAGE DISPLACEMENT

As discussed in Section 4 of this manual, a property that lies in a flood hazard area is periodically inundated by floodwaters. Consequently, during a flood, a certain volume of floodwater will occupy the portion of that property located within the flood fringe, as described in Section 4.2. When fill material or structures are placed above ground in the flood fringe, they occupy space that would otherwise be occupied by floodwaters, which reduces the flood storage volume on the site.

As defined at N.J.A.C. 7:13-1.2, *fill* refers to material placed or deposited on a ground surface, including both soil and structures. In other words, placing soil or other materials on a site for the purpose of raising existing grades constitutes fill. Similarly, constructing any structure above the ground surface, including but not limited to a building, wall, berm, or platform, also constitutes fill.

If a significant volume of floodwater is prevented from occupying a site, the resultant loss of flood storage volume can increase the depth and velocity of flooding, which can lead to deeper floodwaters, wider extents of flooding, increased public safety hazards, and loss of property. Deeper and faster flows in channels also increase the potential for erosion, stream bank failure, and downstream sediment deposition, all of which adversely impact fishery resources and other aquatic biota as well as people and property.

Due to these potential negative impacts, N.J.A.C. 7:13-11.4 includes various restrictions on the volume of floodwater that can be displaced by development on a site. Section 5.1 lists the regulated activities that are exempt from some or all of these flood storage displacement limits while Section 5.2 explains the standards for flood storage displacement for all non-exempt activities. Section 5.3 describes various methods that may be used to calculate flood storage displacement volumes, and Section 5.4 provides an example project to illustrate the use of two of those calculation methods. Finally, Section 5.5 explains the requirements for the engineering report and drawings for flood storage displacement calculations.

5.1 Exemptions

While the loss of flood storage volume on a site can lead to offsite increases in flooding and flood damage, certain activities are not subject to the flood storage displacement limitations of N.J.A.C. 7:13-11.4, either in part or in full. These activities may be associated with minor amounts of flood storage displacement, their occurrence in a flood hazard area may be relatively infrequent, or they may be situated in locations where flood storage is not applicable. The exempt activities, which are listed at N.J.A.C. 7:13-11.4(d), are explained below:

1. Any activity in a tidal flood hazard area

- Tidal flood elevations are controlled by the Atlantic Ocean, and the loss of flood storage volume on a site located within a flood hazard area ruled by the ocean will not lead to increases in these flood elevations. Therefore, it is not necessary to compensate for displaced flood storage volume in tidal flood hazard areas. However, FEMA has not studied all regulated tributaries to tidal waters, and therefore, it cannot be assumed that these waters have tidal flood hazard areas rather than fluvial flood hazard areas simply because they are within the tidal flood hazard area of a larger regulated water. An analysis of such a tributary may show that it is fluvially controlled. In these cases, flood storage compensation is required (see Section 5.2 for the standards for flood storage compensation). If an analysis shows that the 10-year flood is fluvially controlled but the corresponding flood hazard area design flood is tidally controlled, no flood storage compensation will be required for the 10-year event (see Section 5.2.1 for an explanation of the flood storage requirements for the 10-year flood and the flood hazard area design flood).

2. Any activity displacing no more than five cubic yards of flood storage volume as determined by the applicant and verified by the Department

3. The reconstruction, enlargement, or other improvement of a lawfully existing railroad, public roadway, or driveway that serves only one single-family home or duplex, provided flood storage displacement is minimized.

- Typical mechanisms of minimization include, but are not limited to, roadway widths that are no greater than required by regulation, the use of retaining walls instead of sloped embankments, and where retaining walls cannot be used, side slopes no greater than 2H:1V.

4. The construction of a new driveway across a regulated water that serves one single-family home or duplex, provided the single-family home or duplex is not part of a subdivision perfected after November 5, 2007 and there is developable land on the other side of the regulated water that cannot be feasibly accessed without crossing the water

- In making this determination, the applicant must consider access to that portion of a site through neighboring properties. If these provisions cannot be met, the construction of the driveway will no longer be exempt from the flood storage displacement standards.

5. The construction, reconstruction, relocation, elevation, or enlargement of one single-family home or duplex, provided the single-family home or duplex is not part of a subdivision perfected after November 5, 2007 and the standards of N.J.A.C. 7:13-12.5(p) are met

6. The construction or maintenance of a flood control project, provided the project meets the requirements of N.J.A.C 7:13-12.12 and flood storage volume displacement is minimized

7. The restoration of a regulated water to a natural condition, provided the project meets the requirements of N.J.A.C 7:13-12.14 and flood storage volume displacement is minimized

8. The depositing of sediment removed from a channel condition, provided the project meets the requirements of N.J.A.C 7:13-12.15(f)

For the following activities, compliance with the zero percent displacement standards (described in Section 5.2) is not required, but all flood storage volume displacement is limited to a maximum of 20 percent of the flood storage volume onsite (existing at the time of application).

1. The repair, modification, or reconstruction of a malfunctioning individual subsurface sewage disposal system, provided the repair does not result in an expansion of the sewage disposal system
2. Investigation, cleanup, or removal of hazardous substances, provided all flood storage volume displacement is minimized and compensated for to the maximum extent practicable
3. Landfill closure activities authorized under a solid waste landfill closure and post-closure plan or disruption approval, provided all flood storage displacement is minimized and compensated for to the maximum extent practicable

5.2 Flood Storage Displacement Requirements

Except for the activities described in Section 5.1 above, flood storage compensation must be provided for all proposed flood storage volume displacement on a site through the creation of equal or greater flood storage elsewhere so that there is no overall loss of flood storage. To balance the displacement of flood storage resulting from fill and/or construction in the flood fringe, an applicant has two options:

1. **Create an equal amount of flood storage onsite**
2. **Displace up to a total of 20 percent of the flood storage onsite and balance the remaining loss of storage by creating an equivalent amount of additional flood storage offsite**

The Department recognizes that it may not always be feasible to achieve zero-percent flood storage volume displacement on a given site. In such cases, a limit of 20 percent displacement is enforced and nearby offsite compensation is required for that flood storage displacement. Therefore, both options result in no overall net loss of flood storage volume. This standard applies to both the volume displaced between the flood hazard area design flood and the 10-year flood and the volume displaced between the 10-year flood and the ground (see Section 5.2.1).

The baseline for determining changes in flood storage volume, both onsite and in total (including offsite credits), differs in various geographic areas of New Jersey, as explained in Section 5.2.2.

Please note that N.J.A.C. 7:13-1.2 defines *site* as "…the area within the legal boundary of the property, properties, or right-of-way upon which any action … is requested, proposed, occurring, or has occurred, plus any contiguous land owned or controlled by the same person(s)." For the purposes of the flood storage displacement standards, *onsite* refers to areas within those boundaries while *offsite* refers to areas outside of those boundaries.

Whether provided onsite, offsite, or both, compensation for flood storage displacement is required to:

- **Allow floodwaters to freely flow in and out at all times during a flood event, which is known as *effective* flood storage** — **See Section 5.2.3**
- **Meet certain location requirements** — **See Section 5.2.4**

Please note that flood storage compensation must be provided for the loss of any of the following:

- **Ineffective storage areas**

  Ineffective storage areas still provide a measure of flood storage volume, if only once during the course of a flood. Therefore, compensation is required when they are removed. See Section 5.2.3 for a discussion of effective v. ineffective flood storage compensation areas.

- **The volume inside a stormwater management basin or other impoundment**

  For instance, when calculating the flood storage volume onsite during the 10-year flood (see Section 5.2.1), the volume below the 10-year water surface elevation in the basin is considered displaced flood storage volume.

- **The volume behind a dike, levy, or similar barrier that prevents the free flow of water**

- **The volume inside a building except for the space inside an enclosure below the lowest floor of a building that conforms to the requirements at N.J.A.C. 7:13-12.5(p)**
- **The volume in the flood fringe between the existing and proposed flood elevations for the construction of a channel modification or the reconstruction of a water control structure, such as a bridge or culvert, that results in lower flood elevations at some point along the water**

The removal of any fill or structures placed in violation of the FHACA Rules does not constitute adequate compensation. Fill or structures placed in a flood fringe without prior Department approval and therefore without compensation results in the loss of flood storage volume. Removing unlawful fill or structures as compensation for additional proposed flood storage volume displacement does not address the original, illegal loss of flood storage volume. As a result, such compensation cannot be credited toward the new development.

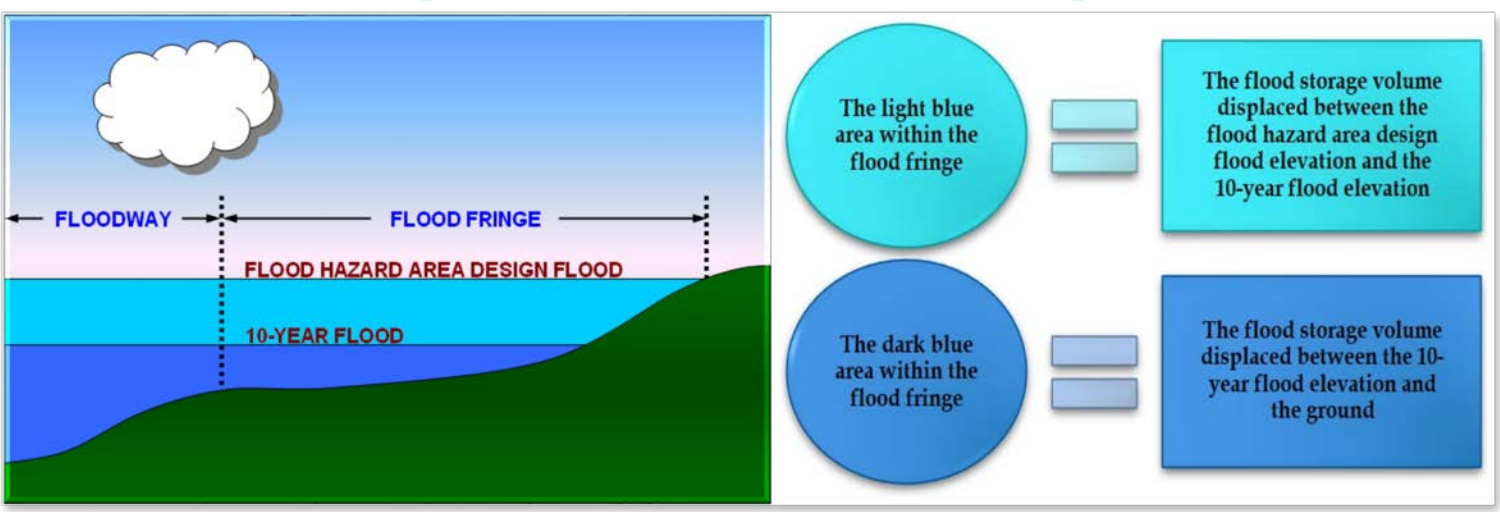
5.2.1 Storage for 10-Year and Flood Hazard Design Floods

As required at N.J.A.C. 7:13-11.4(c), flood storage volume compensation must be provided for both of the following:

- **The volume displaced on a site between the flood hazard area design flood elevation and the 10-year flood elevation**
- **The volume displaced between the 10-year flood elevation and the ground**

Figure 5.1 below illustrates how the flood storage volume displacement standards apply to both areas:

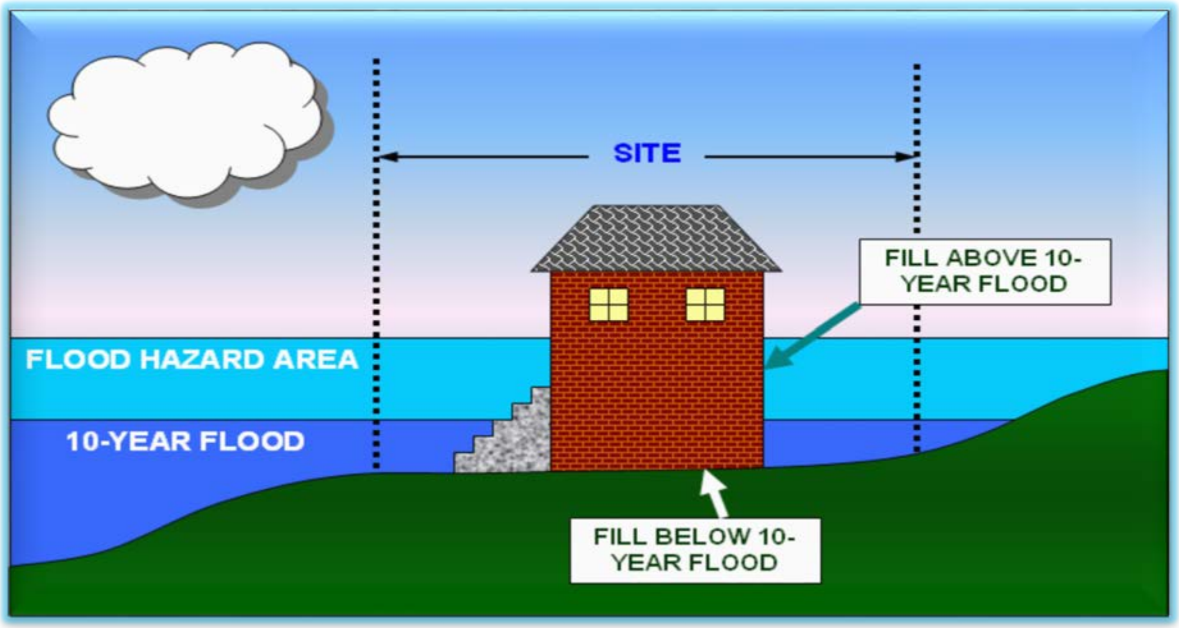
Figure 5.1: Divisions of the Flood Fringe



The flood storage volume displacement standards are applied in these two areas to preserve flood storage for both smaller floods (from the ground to the 10-year flood elevation) and larger floods (from the 10-year flood elevation to the flood hazard elevation). For example, if the majority of flood storage volume displacement occurs in the lower elevations of the flood hazard area but most of the compensation is provided in the higher elevations, smaller floods will not be able to access the compensation areas, and therefore, effective compensation is not provided for smaller flood events and both the extent of flooding and associated flood damage will ultimately increase. Conversely, if significant flood storage volume is eliminated from higher elevations of the flood hazard area but compensation is only provided in the lower elevations, the compensatory storage volume will not be available for storage during larger storm events because that storage area will be occupied earlier in the flood event and will not be available to store floodwaters at times in and around the peak flood. This ultimately results in increased flooding during these larger storm events.

The Department recognizes that meeting this standard may not always be possible on a given site. For example, a site may lie completely or predominately below the 10-year flood elevation, as shown in Figure 5.2 below.

Figure 5.2: Flood Storage Compensation on a Site Situated Entirely Below the 10-Year Flood Elevation



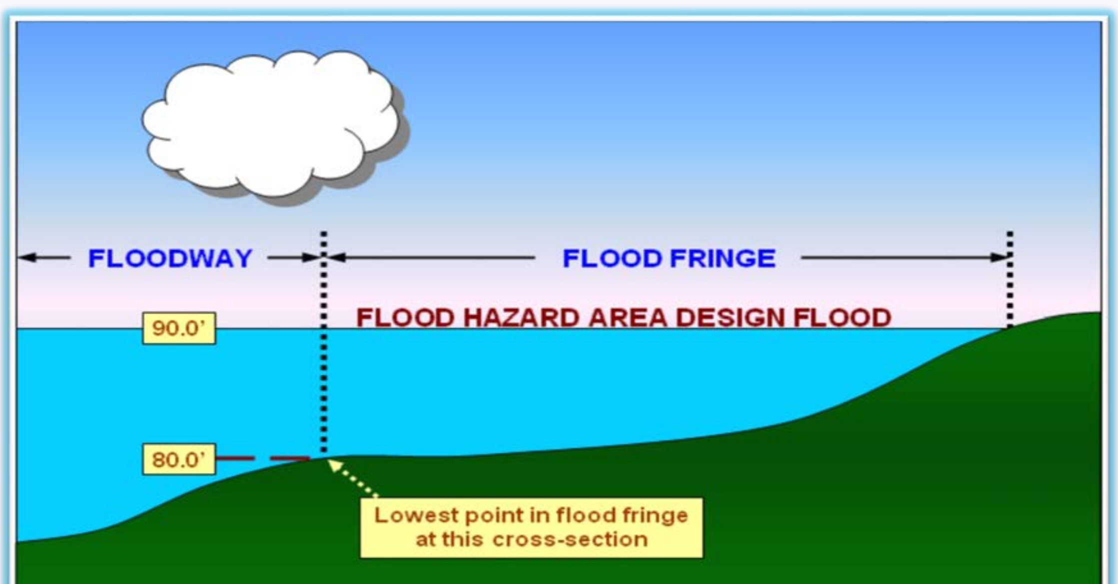
On such a site, providing onsite compensation for any flood storage displacement above the 10-year flood elevation, such as from the upper half of a building being constructed on the lot, may not be possible. This requirement is particularly problematic in cases where there is currently no development onsite above the 10-year flood that could be removed or modified to compensate for the fill proposed above the 10-year flood. In such situations, onsite compensation must be provided above the 10-year flood to the maximum extent practicable according to the standards at N.J.A.C.

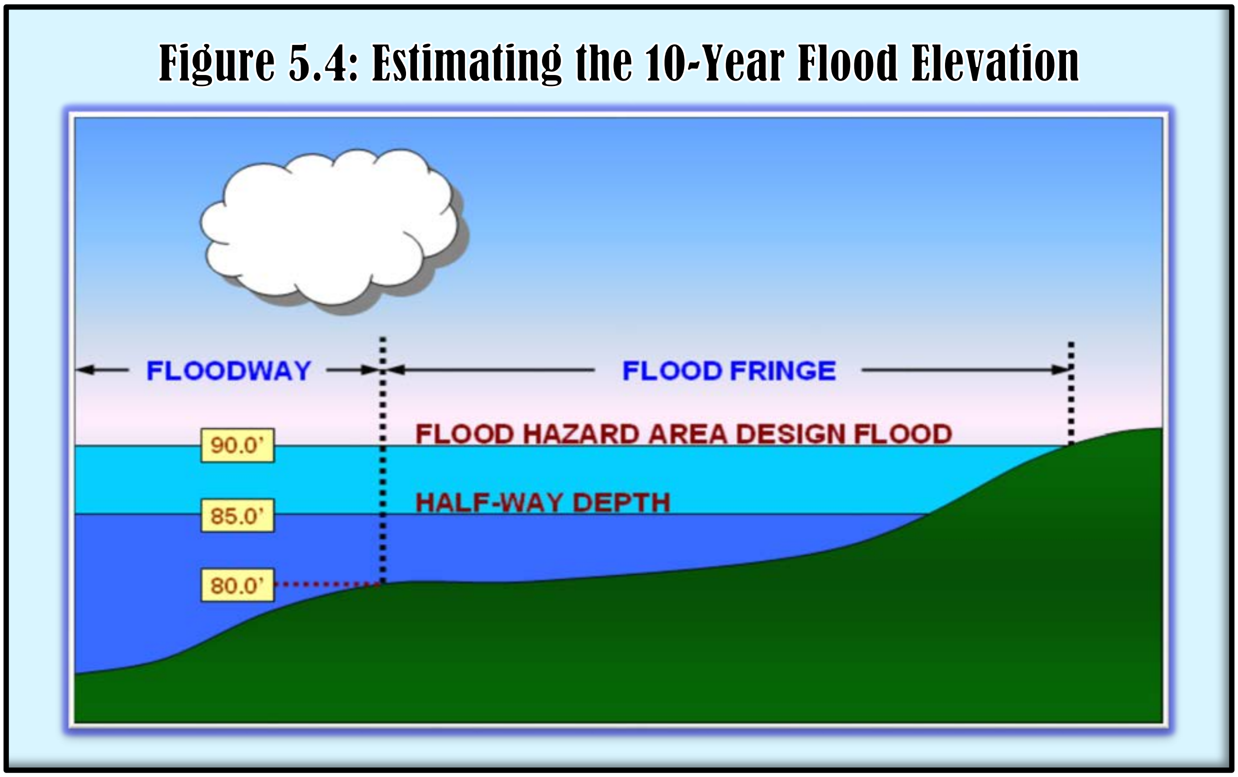
7:13-11.4(m). Then, if offsite flood storage volume compensation above the 10-year flood elevation can satisfy the flood storage displacement standards of N.J.A.C. 7:13-11.4, this option must be used. Only if offsite compensation above the 10-year flood elevation is not viable or sufficient can the Department allow compensation for flood storage displacement proposed above the 10-year flood elevation to occur below the 10-year flood elevation, either onsite or offsite, as provided at N.J.A.C. 7:13-11.4(j)4(iii).

While the 10-year flood is an essential parameter for flood storage displacement, this elevation is not always readily available and must be determined by the applicant. When using Method 3, the FEMA fluvial method (see Section 4.4.2), the 10-year flood elevation can be referenced from the FIS booklet. When using Method 6, the calculation method (see Section 4.4.4), the same model used to determine the 100-year and flood hazard area design flood elevations can easily be adjusted to account for the 10-year storm to produce the 10-year flood elevation. For all other cases, the Department will accept an estimation of the 10-year flood elevation. Under N.J.A.C. 7:13-11.4(j)5, the 10-year flood elevation may be estimated as the elevation corresponding to the flood depth halfway between the flood hazard area design flood elevation and the lowest ground elevation within the flood fringe. Note that considering any land located within the floodway is not appropriate when determining this measurement.

As an example, in Figure 5.3 below, the flood hazard area design flood elevation is 90.0 feet NAVD and the lowest ground elevation of effective flow area within the flood fringe is 80.0 feet NAVD. However, the 10-year flood elevation is not indicated. By a simple estimation, the 10-year flood elevation would be 85.0 feet NAVD, as shown in Figure 5.4 on the next page. (Please note that the lowest point in the flood fringe at a particular cross-section is often not located at the floodway limit as shown in these figures.)

Figure 5.3: The Flood Hazard Area Design Flood Elevation without a 10-Year Flood Elevation





However, the 10-year flood elevation cannot be determined at only a single point on a site along a regulated water because the resulting estimation would be inaccurate. Multiple cross-sections must be taken across a site. Similar to a Method 6 analysis (see Section 4.4.4), there is no set number of cross-sections required along a site. Engineering judgement must be used to place cross-sections at intervals sufficient to capture the topographic changes that occur within the flood fringe. Existing conditions must be based on a survey that has been signed and sealed by a New Jersey licensed professional land surveyor, and the 10-year flood elevation must be plotted on each cross-section. Then, the 10-year flood elevation may be smoothed to eliminate inconsistencies that may arise in certain situations, as demonstrated by the following examples.

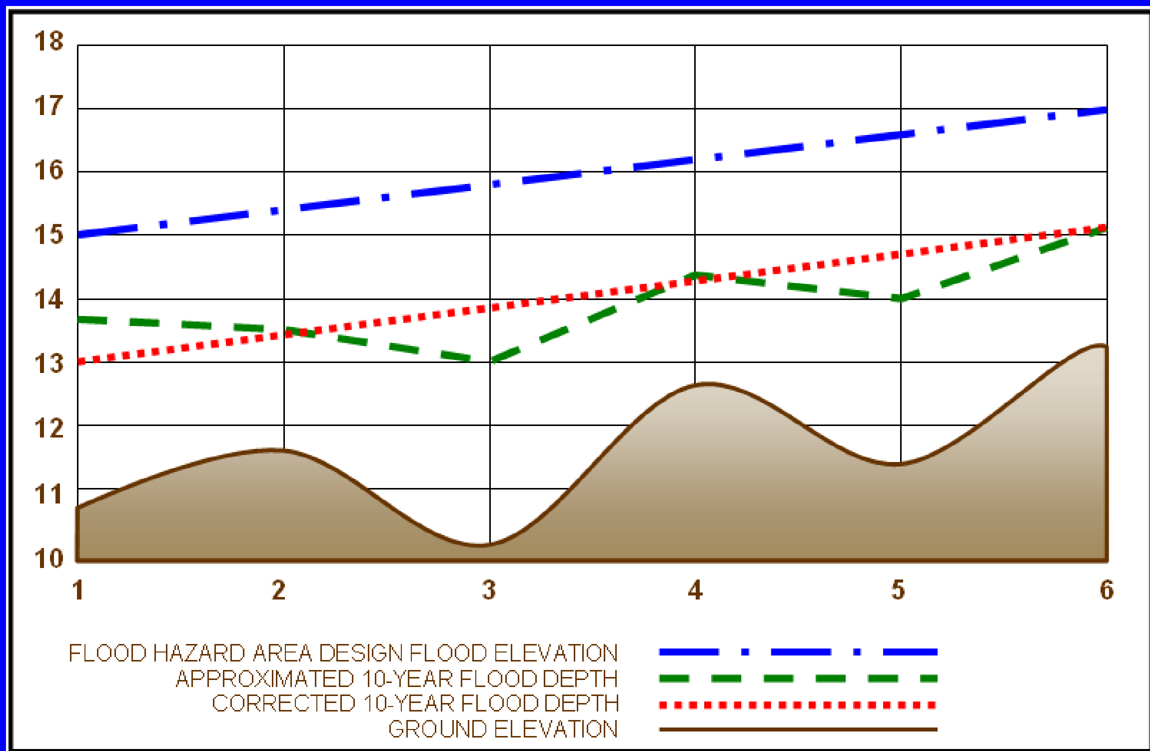
EXAMPLES:

EXAMPLE 1

Figure 5.5 on the next page is a profile view of a portion of a typical site. The X-axis represents locations of cross-sections 1 through 6. The Y-axis represents elevations referenced to NAVD.

The lowest ground elevation in the flood fringe varies from one cross-section to the next. The lowest ground elevations for cross-sections 1 through 6 are 12.4 feet, 11.6 feet, 10.2 feet, 12.6 feet, 11.4 feet, and 13.2 feet NAVD, respectively. The flood hazard area design flood elevation, plotted in blue, has a constant slope between 15 feet and 17 feet NAVD. Specifically, the respective flood hazard elevations at cross-sections 1 through 6 are 15.0 feet, 15.4 feet, 15.8 feet, 16.2 feet, 16.6 feet, and 17.0 feet NAVD.

Figure 5.5: Adjusting the Estimated 10-Year Elevation

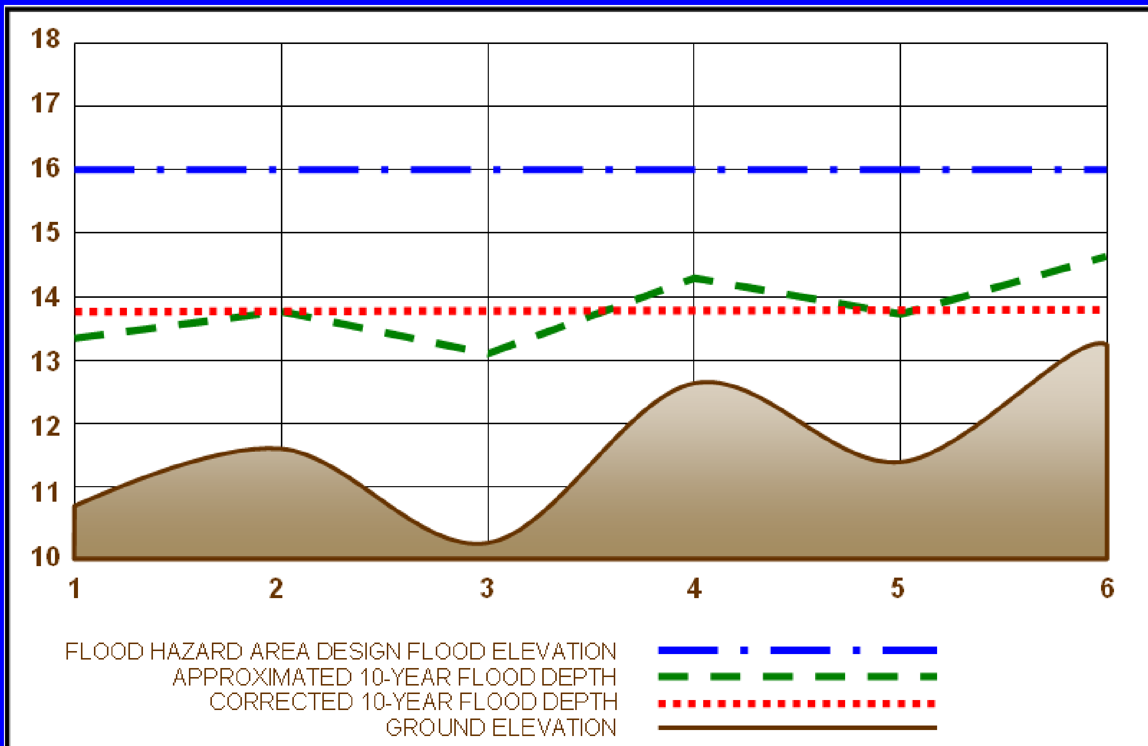


The estimated respective 10-year flood elevations would then be 13.7 feet, 13.5 feet, 13.0 feet, 14.4 feet, 14.0 feet, and 15.1 feet NAVD (representing the flood depth halfway between the flood hazard area design flood elevation and the lowest ground elevation). However, under normal flow conditions, the 10-year flood would be expected to rise consistently going upstream, similar to the flood hazard design flood elevation. The estimated 10-year flood elevations can be adjusted to reflect this by transferring the lowest calculated elevation to cross-section 1 and the highest elevation to cross-section 6 and then connecting the two data points with a straight line. This will result in more consistent and reasonable 10-year flood elevations on site for each cross-section. The revised 10-year flood elevations at cross-sections 1 through 6 would be 12.9 feet, 13.4 feet, 13.8 feet, 14.2 feet, 14.6 feet, and 15.1 feet NAVD, respectively. These revised values should be used for flood storage volume calculations.

EXAMPLE 2

Figure 5.6 on the next page refers to a site with the same topography as the site in Example 1 except that the regulatory flood elevation is 16.0 feet NAVD throughout the site. The flood depths halfway between the flood hazard area design flood elevation and the lowest ground elevation for cross-sections 1 through 6 are 13.4 feet, 13.8 feet, 13.1 feet, 14.3 feet, 13.7 feet, and 14.6 feet NAVD. However, under normal flow conditions, the flood hazard elevation does not vary throughout the site, so the 10-year flood elevations should also be constant for this example site. In such a case, the calculated 10-year flood elevations may be averaged to arrive at a constant elevation. Therefore, the resultant 10-year flood elevation would be 13.8 feet NAVD through the project site.

Figure 5.6: Adjusting the Estimated 10-Year by Taking the Average Median Elevation



It is important to note that assuming a constant 10-year flood elevation when the flood hazard area design flood elevation is constant is not always appropriate. For example, a downstream control structure, such as a bridge or culvert, could pass the 10-year flood but not the flood hazard area design flood, which might be the cause for a constant flood hazard design area design flood elevation but would not necessarily cause the 10-year flood elevation to also be constant. In such a case, the 10-year flood elevation may need to be adjusted in the manner described in Example 1.

Note: The rationale for any adjustments made to the approximate 10-year flood, as outlined above or otherwise, should be clearly explained in the application's engineering report so that Department staff can understand and evaluate the methods being used. See Section 5.5 below.

5.2.2 Geographic Flood Storage Displacement Limits

To address both the environmental sensitivity and the severity of flooding in different regions of the State, the standards for determining the change in flood storage volume are applied slightly differently depending upon where in New Jersey a site is located. The various geographic areas and the corresponding standards are found in Table 11.4 at N.J.A.C. 7:13-11.4(d), which is reprinted below.

Table 11.4
ALLOWABLE PERCENTAGES OF FLOOD STORAGE VOLUME DISPLACEMENT
(Which shall be met for both the volume between the flood hazard area design flood and the 10-year flood, and the volume between the 10-year flood and the ground)

Geographic Area	**Maximum onsite percentage of flood storage volume that a project can lawfully displace (PONSITE)**	**Maximum total percentage of flood storage volume that a project can lawfully displace including all offsite credits (PTOTAL)**
Central Passaic Basin	20 percent of flood storage that existed onsite on March 25, 1977	0 percent of flood storage that existed onsite on March 25, 1977
Highlands Preservation Area*	20 percent of flood storage that existed onsite on January 31, 1980	0 percent of flood storage that existed onsite on August 10, 2004
Remainder of State	20 percent of flood storage that existed onsite on January 31, 1980	0 percent of flood storage that existed onsite on November 5, 2007

*If associated with Major Highlands Development, as defined at N.J.A.C. 7:38-1.4.

As noted by the table, these limits apply to both the volume between the flood hazard area design flood and the 10-year flood and the volume between the 10-year flood and the ground. See Section 5.2.1 for more information.

Table 11.4 divides the State into the Central Passaic Basin, the Highlands Preservation Area, and the remainder of the State. The Central Passaic Basin is defined at N.J.A.C. 7:13-1.2, and it encompasses the flood hazard areas of portions of 13 different regulated waters located in portions of Morris, Somerset, and Passaic Counties. The Highlands Preservation Area includes portions of Bergen, Passaic, Sussex, Morris, Warren, Somerset, and Hunterdon Counties. The exact boundaries are described in the Highlands Water Protection and Planning Act Rules at N.J.A.C. 7:38 and can be viewed in the Department's GeoWeb application at http://www.nj.gov/dep/gis/geowebsplash.htm. If the GeoWeb depiction of the preservation area differs from the description at N.J.A.C. 7:38, the rules will govern.

The different dates listed in Table 11.4 serve as the baseline for calculating changes in flood storage volume in the corresponding geographic area. For example, for the 20 percent onsite flood storage volume displacement limit in the Central Passaic Basin, the base flood storage volume is the volume of the flood fringe that existed onsite on March 25, 1977. The rules reference this date because the Department first began regulating flood storage displacement within the Central Passaic Basin at that time. With respect to the twenty percent limit outside the Central Passaic Basin, the base flood storage volume is the volume of the flood fringe that existed onsite on January 31, 1980. The rules reference this date because it is the date the current Flood Hazard Area Control Act was adopted.

For the zero-percent overall flood storage volume displacement limit, the Central Passaic Basin references March 25, 1977 as a baseline for comparison, which is the same date that applies to the 20 percent standard. Similarly, the Highlands Preservation Area was adopted on August 10, 2004, so that date is used as the benchmark for determining compliance with the zero-percent standard for any regulated activity identified as a Major Highlands Development in N.J.A.C. 7:38. For the remainder of the State, the date used is November 5, 2007, the date that the FHACA Rules first mandated zero-percent overall flood storage volume displacement for areas other than the Central Passaic Basin and the Highlands Preservation Area.

The following examples illustrate the application of the flood storage displacement standards for these different geographic areas as described at N.J.A.C. 7:13-11.4(g), (h), and (i). Note that *cut* refers to removing structures or soil from the surface, which lowers the grade, while *fill* refers to placing or depositing material on the surface, which raises the grade. See Section 5.3 of this manual for information on the various methods that can be used to calculate flood storage volumes.

EXAMPLES:

Example 1: Balancing fill onsite	
Flood storage before project (V_E):	1,000 yd³
Flood storage after project (V_P):	1,000 yd³
Storage that must be created (V_C):	0 yd³ (All cut and fill is balanced onsite)

Example 2: Central Passaic Basin	
Flood storage onsite in 1977 (V_{1977}):	1,000 yd³
Flood storage onsite after project (V_P):	950 yd³
Flood storage displacement:	1,000 yd³ - 950 yd³ = 50 yd³
Percent of 1977 flood storage displacement:	50 yd³ / 1,000 yd³ = 5% < 20% (complies with rule)
Storage that must be created (V_C):	50 yd³

Example 3: Highlands Preservation Area (no fill placed onsite between 1980 and 2004)	
Flood storage onsite in 1980 (V_{1980}):	1,000 yd^3
Flood storage onsite after project (V_P):	900 yd^3
Flood storage displacement:	1,000 yd^3 - 900 yd^3 = 100 yd^3
Percent of 1980 flood storage displacement:	100 yd^3 / 1,000 yd^3 = 10% < 20% (complies with rule)
Storage that must be created (V_C):	100 yd^3

Example 4: Highlands Preservation Area (fill placed onsite between 1980 and 2004)	
Flood storage onsite in 1980 (V_{1980}):	1,000 yd^3
Fill placed onsite between 1980 and 2004:	100 yd^3
Flood storage onsite in 2004 (V_{2004}):	1,000 yd^3 - 100 yd^3 = 900 yd^3
Proposed work will add another 50 yd^3 of fill onsite.	
Flood storage onsite after proposed work (V_P):	900 yd^3 - 50 yd^3 = 850 yd^3
Final flood storage displacement:	1,000 yd^3 - 850 yd^3 = 150 yd^3
Percent of 1980 flood storage displacement:	150 yd^3 / 1,000 yd^3 = 15% < 20% (complies with rule)
Storage that must be created (V_C):	50 yd^3

Note: The 100 yd^3 of fill placed onsite between 1980 and 2004 does not require compensation since prior to 2004 applicants were permitted to fill up to 20 percent of the flood storage volume without offsite compensation.

Example 5: Remainder of State (no fill placed onsite between 1980 and 2007)	
Flood storage onsite in 1980 (V_{1980}):	1,000 yd^3
Flood storage onsite after project (V_P):	875 yd^3
Flood storage displacement:	1,000 yd^3 - 875 yd^3 = 125 yd^3
Percent of 1980 flood storage displacement:	125 yd^3 / 1,000 yd^3 = 12.5% < 20% (complies with rule)
Storage that must be created (V_C):	125 yd^3

Example 6: Remainder of State (fill placed onsite between 1980 and 2007)	
Flood storage onsite in 1980 (V_{1980}):	1,000 yd^3

Fill placed onsite between 1980 and 2007:	100 yd^3
Flood storage onsite in 2007 (V_{2007}):	1,000 yd^3 - 100 yd^3 = 900 yd^3
Proposed work will add another 75 yd^3 of fill onsite.	
Flood storage onsite after proposed work (V_P):	900 yd^3 - 75 yd^3 = 825 yd^3
Final flood storage displacement:	1,000 yd^3 - 825 yd^3 = 175 yd^3
Percent of 1980 flood storage displacement:	175 yd^3 / 1,000 yd^3 = 17.5% < 20% (complies with rule)
Storage that must be created (V_C):	75 yd^3

Note: The 100 yd^3 of fill placed onsite between 1980 and 2007 does not require compensation since prior to 2007 applicants were permitted to fill up to 20 percent of the flood storage volume without offsite compensation.

5.2.3 Effective Flood Storage Compensation

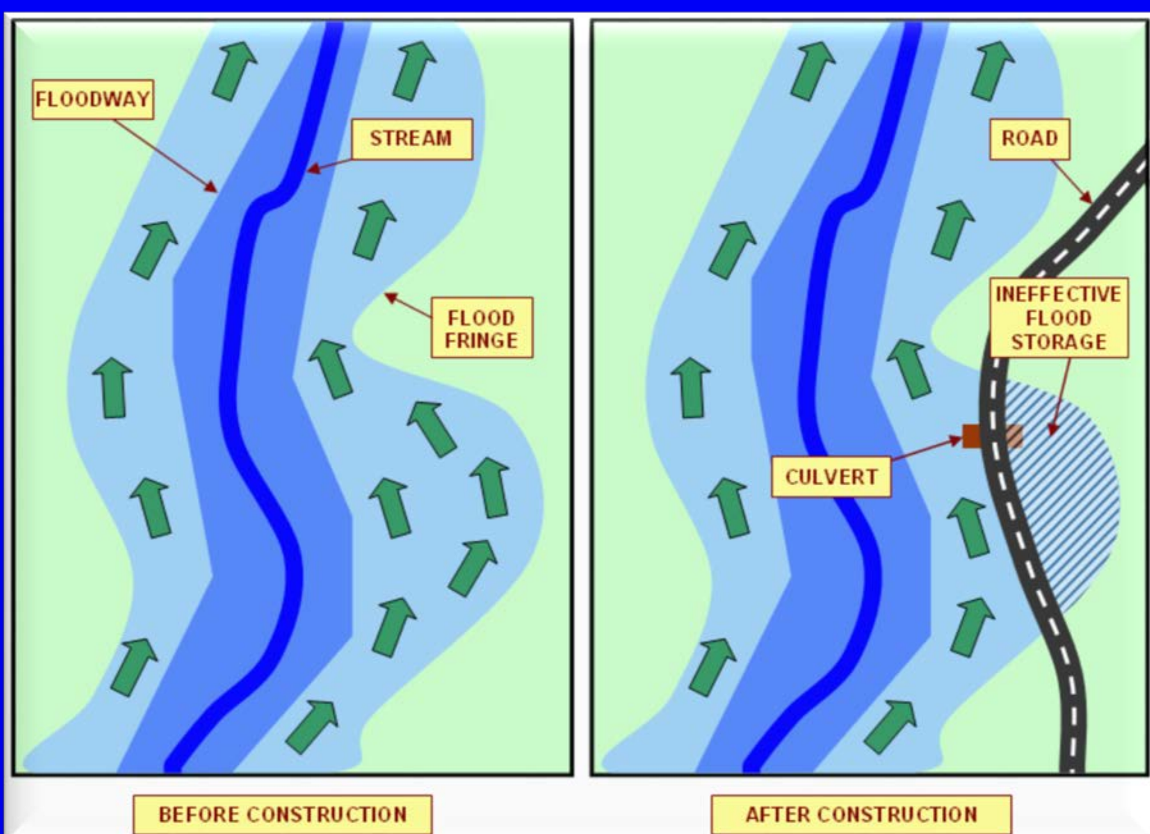
Compensation must allow floodwaters to freely flow in and out at all times during a flood event. During the course of a flood, floodwaters continually enter and exit a site. Therefore, flood storage on a site is dynamic, not static, in proportion to the velocity of the floodwaters. In other words, the flood fringe collects and discharges the flood storage volume an infinite number of times during the course of a flood, not just once.

Imagine a bathtub full of water. The bathtub holds a certain volume of water, determined by the shape and size of the tub. However, a site that lies in a flood fringe does not typically fill up with water like a bathtub at the beginning of a flood and then release the water when the flood is over. Instead, water continually enters and exits the site during a flood. A site within a flood fringe is more like a bathtub with the faucet on and the drain open at the same time. Water continually and simultaneously enters and exits the tub. So, while the actual volume of the bathtub is static, the total volume of water passing through the tub could be many times that volume if the faucet is left on for a period of time.

Therefore, any flood storage volume created to compensate for fill or structures must be *effective*, meaning that floodwaters must be allowed to freely enter and exit the created area throughout the entire duration of a flood event, as required by N.J.A.C. 7:13-11.4(j). Credit cannot be granted for created areas that will simply fill up with floodwaters and remain full during the course of the flood, like a stoppered bathtub. For example, applicants sometimes propose to create below-ground chambers that are connected to the flood fringe by pipes that fill up with floodwaters and remain full until the flood recedes. Such areas are not effective flood storage since there is no free exchange of floodwaters during the course of the flood. Applicants also sometimes propose to create isolated depressions or other similar above-ground areas on the edge of a flood fringe that are connected to the flood hazard area via pipes or other channels. While it is true that floodwaters can enter and fill up these areas, there is no free exchange of floodwaters during a flood, so these areas are not effective flood storage.

Another example is shown in Figure 5.7 below, which illustrates a flood hazard area before and after the construction of a road. Prior to construction, floodwaters (represented by the green arrows) can freely pass through the entire flood fringe area. The construction of the road, however, truncates a portion of the flood fringe so that floodwaters cannot freely enter and exit the area to the right of the road during the course of the flood. The culvert allows floodwaters to fill up the area to the right of the road, but once this area is filled, it becomes ineffective to further inflow and therefore does not contribute to the effective flood storage volume of the flood fringe.

Figure 5.7: Ineffective Flood Storage



However, if the road in Figure 5.7 were constructed on pilings (such as a causeway) or with many culverts (so that floodwaters could freely move from one side of the road to the other), the area to the right of the road may be considered effective flood storage. The number and types of culverts required is a function of the amount of obstruction the road represents. Roads involving significant fill will require more and larger culverts, but roads with less fill would require fewer culverts. Engineering judgement must be used in such situations. While the placement of as many culverts as possible is preferred, an applicant should contact the Department to speak with a staff engineer from the Division of Land Use Regulation for guidance regarding the minimum number and types of culverts that would be required for a given project.

When calculating effective flood storage, areas of "dead space" or "dead storage" during a flood event must also be considered as ineffective storage. Normally minimal, these include areas below flood vents or within stormwater basins into which floodwaters can enter due to gravity but cannot exit without a pump or through other mechanical or manual means. Such areas will quickly fill up during a flood but will stay filled with water once the remainder of floodwaters recede and exit.

5.2.4 Requirements for the Location of Flood Storage Compensation Areas

Whether onsite or offsite, all flood storage compensation areas must be located:

Along the same regulated water as the proposed displacement

Compensation cannot be accomplished along a different watercourse, even if that watercourse is on the same site.

Within a flood fringe

Compensation cannot be provided within a floodway. Flood storage is the primary function of the flood fringe, but the floodway, on the other hand, is reserved for the conveyance of floodwaters for the purposes of the FHACA Rules. As such, the portion of the flood hazard area contained within the floodway is not included in any flood storage volume calculations.

Above the seasonal high groundwater table

During wetter months, typically January through April, the groundwater table is at its highest elevation. If a compensation area were situated below the elevation of the seasonal high groundwater table, groundwater would enter the compensation areas during the wet times of year, and consequently, those areas would not be available for the storage of floodwaters because they would already be occupied by groundwater. This negates the required functionality of the compensation area and is therefore not permitted under N.J.A.C. 7:13-11.4(r).

However, flood storage compensation areas may not be located:

Within any undisturbed riparian zone or within undisturbed areas located within 300 feet of a Highlands open water

These areas provide critical environmental functions and should not be disturbed to offset the impacts of development. Similarly, compensation is not allowed in any areas that would cause other adverse impacts, such as the degradation or removal of threatened or endangered species habitat.

Below the normal water surface elevation of the regulated water

The compensation area is required to be hydrologically connected to the regulated water. If it is situated below the normal water surface elevation, the compensation area would immediately fill with water during floods and therefore would not be available to store floodwaters from either the 10-year or flood hazard events.

5.3 Methods for Calculating Flood Storage

The two most common methods for calculating flood storage for the purpose of demonstrating compliance with the 20 percent and zero percent flood storage volume displacement limits (see Section 5.2) are the Average End Area Method (Cross-section Method), explained in Section 5.3.1, and the Grid Method, explained in Section 5.3.2. Section 5.4 provides an example project that demonstrates the use of these two methods.

Alternately, a computer program can be used to accurately calculate existing and proposed flood storage volumes from Triangular Irregular Networks (TIN). However, the TIN models that generate flood storage volumes must be formatted so that the Department is able to verify the accuracy of the input that was entered into the program to generate the submitted results, as explained in Section 5.3.3. See Section 5.5 for information on how to report flood storage calculations to the Department under a flood hazard area permit.

5.3.1 The Average End Area Method

This method involves five steps:

Step 1	**Create a number of cross-sections throughout a site.**
Step 2	**Calculate the area of each cross-section in the flood fringe between the flood hazard area design flood elevation and the 10-year flood (the upper slice of the flood fringe) and also between the 10-year flood and the ground (the lower slice of the flood fringe).**
Step 3	**Find the average area of each adjacent cross-section (i.e., the average area of cross-sections 1 and 2, the average area of cross-sections 2 and 3, etc.) for both the upper and lower slices of the flood fringe.**
Step 4	**Multiply each average area by the distance between the two adjoining cross-sections to determine the flood storage volume between the two cross-sections for both slices.**
Step 5	**Sum the flood storage volume between each pair of adjacent cross-sections to yield the total volume of the flood fringe onsite for both slices.**

Section 5.4 provides an example project to demonstrate the application of this method. To ensure accurate results, the following **special considerations** must be taken into account:

1. If the floodway is located on the project site, the floodway line must be shown on each cross-section that intersects the floodway. It is important to note that since the flood storage displacement limits only apply to the flood fringe, the area of the cross-section within the floodway may not be included in the area of the cross-section.

2. Cross-sections used for the calculations must be parallel to each other so that there is a constant distance between any two cross-sections. Cross-sections used for hydraulic modeling of a stream are generally not parallel and therefore cannot typically be used for flood storage calculations.

3. In many cases, flood elevations will vary through a project site, and thus, the flood elevation must be varied accordingly at each cross-section to match the flood elevation at that location.

4. Cross-sections must be carefully selected to accurately calculate flood storage volumes. For instance, cross-sections should not necessarily be chosen at regular intervals if doing so will miss significant depressions or high areas on the site. Also, it may be necessary to add cross-sections to accurately reflect loss of storage associated with buildings. It is particularly important to locate a cross-section at each face of a building wall and then calculate two separate areas – one looking away from the building (to calculate the area just outside the building wall) and one looking into the building (to calculate the area just inside the building wall).

5. In some cases, it may be more accurate to have a separate calculation for certain structures for which the flood storage volume is not easily calculated or may be missed altogether by the Average End Area Method. For example, if an applicant constructs a crawl space with a floor elevation below the flood elevation, floodwaters can enter the crawl space through the required flood vents. The area within the enclosed crawl space will therefore still provide flood storage, albeit ineffective flood storage (see Section 5.2.3 for a discussion of effective v. ineffective flood storage). However, the foundation walls and any interior walls and columns within the crawl space must be accounted for and may best be handled by separate calculations. Other items that might need special consideration include, but are not limited to, small decks and porches, raised gardens, and material or equipment that will be stored in the flood hazard area.

5.3.2 The Grid Method

Under the Grid Method, a grid is superimposed over a grading plan, effectively dividing the site into a series of cells, which will be comprised of squares and other polygons. In the case of squares and rectangles (for other geometric shapes, see special consideration 3 on the next page), the spot elevations of the four corners are averaged, and the average elevation is subtracted from the flood elevation to achieve an average depth of floodwaters within the cell. This depth is then multiplied by the area of the cell to determine the volume of the floodwaters in that cell. The process is then continued until the volume has been determined for each cell of the grid. Then, the volumes of each cell are summed to determine the total volume of the flood storage on the project site. Section 5.4 provides an example project to demonstrate the application of this method.

To ensure accurate results, the following **special considerations** should be taken into account:

1. If the floodway is located on the project site, the floodway line must be shown on the grading plan that has the grid superimposed on it. It is important to be mindful that flood storage displacement limits only apply to the flood fringe, and therefore, portions of the grid that are located within a floodway cannot be included in the calculations.

2. In many cases, flood elevations will vary throughout a project site, and thus, the flood

elevation must vary accordingly at each cell to match the flood elevation at that location.

3. The cells in a grid do not always consist of squares or rectangles. When the grid interfaces with a property line, floodway line, flood elevation line, or an irregularly-shaped structure or other feature, the cell at that interface will not be a square or rectangle. For instance, a property line, floodway line, etc., may cut across a grid at an angle and form a trapezoid or triangle at the interface. If the interface is curvilinear, the cell will have an irregular shape. It is important to note that if the cell is a trapezoid, averaging the four corners of the trapezoid may not yield an accurate ground elevation for the trapezoid. In the case of a triangle or irregular geometric shapes, there may not be four corners to average. In any of these cases, it is important to look at the topography throughout the cell and then use engineering judgment to estimate the average ground elevation within that cell.

4. When the ground slope changes abruptly or the contour lines are otherwise irregular within a rectangular area, averaging the four corners may not yield an accurate ground elevation. In some cases, this problem can be rectified by breaking the cell into smaller cells. This would be the case when the ground slope changes abruptly within the cell. The cell could be divided in two – one portion for the steeper part and one portion for the flatter part. In the case of more irregular topography, engineering judgment should be used to estimate the average ground elevation within the cell.

5. As noted above, irregular topography can make it difficult to determine the average ground elevation within a cell. For this reason, it is very important to select a grid size that will provide an adequate level of accuracy. In general, 25-foot by 25-foot squares provide a sufficient level of accuracy. A site with irregular topography may require smaller grids to provide accurate flood storage calculations. However, if a site is very flat, somewhat larger cells can be used with little or no impact on accuracy.

6. In some cases, it may be more accurate to provide a separate calculation for certain structures that are not easily calculated or may be missed altogether by the Grid Method. For example, if an applicant constructs a crawl space with a floor elevation below the flood elevation, floodwaters can enter the crawl space through the required flood vents. The area within the enclosed crawl space will therefore still provide flood storage. However, the foundation walls and any interior walls and columns within the crawl space must be accounted for, and separate calculations may be best. Other items that might need special consideration include, but are not limited to, small decks and porches, raised gardens, and material or equipment that will be stored in the flood hazard area.

5.3.3 The TIN Method

The accuracy of the Average End Area Method and the Grid Method is a function of how many cross-sections are generated and how many cells are utilized, respectively. Thus, these methods can be labor intensive. As such, Triangular Irregular Networks (TINs) may also be utilized in certain situations at the Department's discretion.

In the TIN Method, the flood storage volume of a site, or a portion thereof, is calculated through the use of a series of vectors generated by a computer program. At the time of publication of this manual, the Department is drafting guidelines for the submittal of calculations based on the TIN Method, which will appear in a future version of this manual. However, at this time, the Department strongly recommends that an applicant discuss the project with the Department before submitting a permit application with flood storage volume calculations based on the TIN Method.

5.4 Example Project

This example project demonstrates how to use the Average End Area Method (explained in Section 5.3.1) and the Grid Method (explained in Section 5.3.2). At the current time, the TIN Method (explained in Section 5.3.3) is not included in this example.

The following information applies to both methods. Two buildings are proposed on a property that is partially located within the flood hazard area and within the 10-year flood plain, as shown on the site plan in Figure 5.8 on the following page. The floodway boundary is not shown on the site plan because the entire property lies outside of the floodway. The flood hazard area design flood elevation for the site is 23.5 feet NAVD, and the 10-year flood elevation for the site is 21.5 feet NAVD.

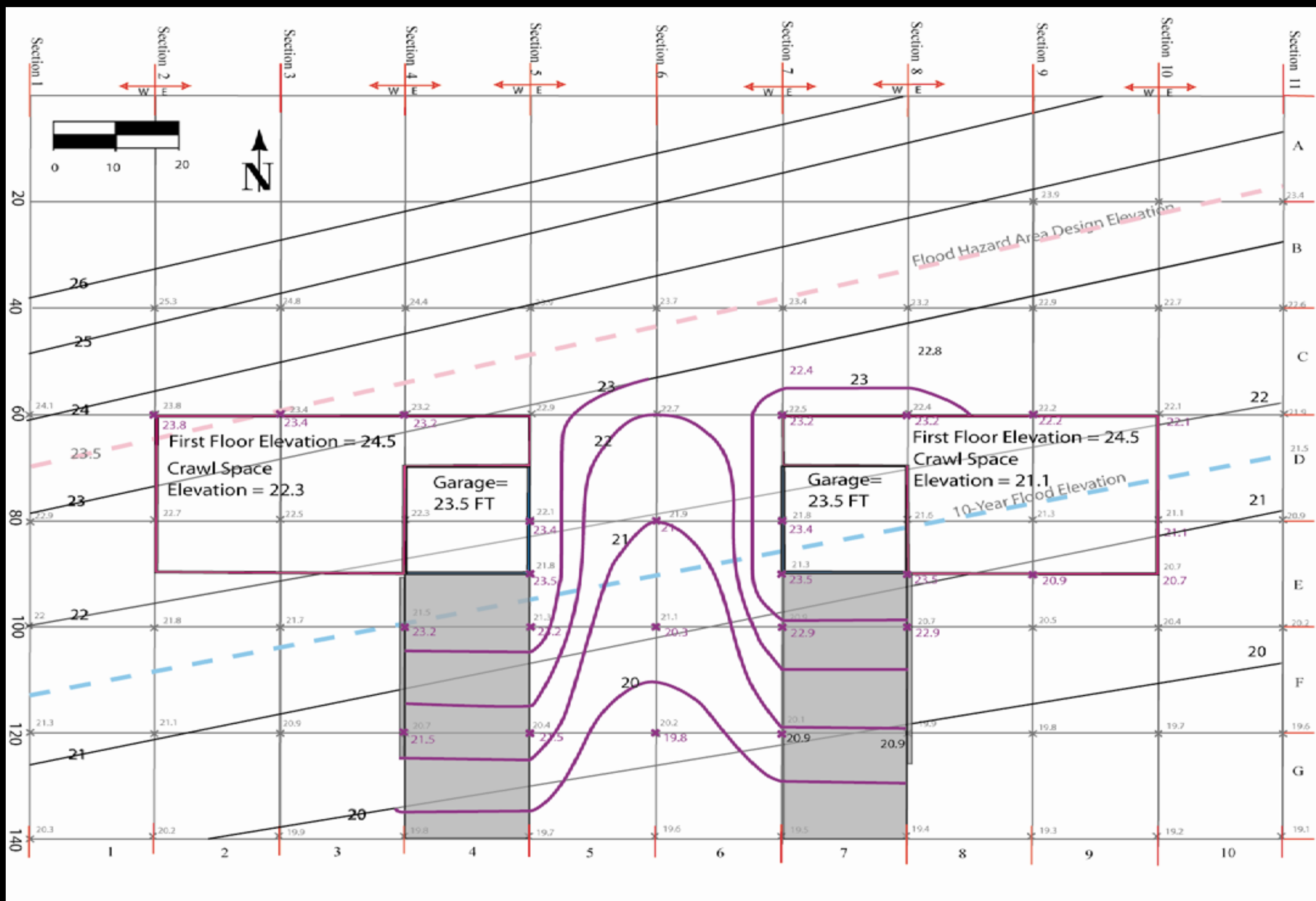
DISCLAIMER

The proposed grading and design of the buildings in this example do not currently satisfy the requirements of N.J.A.C. 7:13. For example, the garage elevations would need to be raised to 24.5 feet NAVD to satisfy N.J.A.C. 7:13-12.5, and the project site would need to be regraded to satisfy the flood storage displacement requirements for both the flood hazard area design and 10-year floods. This example project is only intended to demonstrate how to use the Average End Area Method and the Grid Method and does not imply that a project in contravention of the FHACA Rules will be permitted by the Department.

Some additional details are as follows:

1. The buildings each have a crawl space adjacent to and behind the garage. Both crawl spaces have flood vents that are flush with the floor elevation of the crawl space. The westerly building has a crawl space elevation of 22.3 feet NAVD, which is above the 10-year flood elevation but below the flood hazard area design flood elevation. Therefore, that crawl space will provide flood storage for the flood hazard area design flood but not the 10-year flood. However, the easterly building has a crawl space elevation of 21.1 feet NAVD and will therefore provide storage for both the 10-year and flood hazard area design floods. It is important to note that if the flood vents on the easterly building were placed one foot above the elevation of the crawl space, the crawl space would no longer allow the 10-year flood to enter, and thus, that crawl space would not have storage for the 10-year flood either.

Figure 5.8: Example Problem Layout



2. The foundation walls of both buildings are assumed to be eight inches thick. The flood storage displacement from these walls is to be calculated separately. In this example, the beams and support joists of the low floor do not displace floodwaters.

3. To eliminate the need to fill the front yards, each driveway has a one-foot-wide retaining wall that matches the driveway elevation (the top of the wall is flush with the driveway elevation and the bottom of the wall matches the existing grade). Some minor adjustments are to be made to the calculations to account for these walls.

4. To fit the format of this manual, the size of the site plan has been reduced from the indicated scale of 1" = 20'. To determine the actual scale of the reduced version, please reference the site plan's bar scale, which has been reduced proportionally with the drawing. To simplify calculations, cross-sections in this example are generally spaced 20 feet apart for the Average End Area Method, and the cells of the grids are generally 20 feet by 20 feet for the Grid Method. Note that for the purposes of application submittal, a true scale must be included on all site plans so the Department can verify the accuracy of the calculations.

The use of the Average End Area Method and the use of the Grid Method to calculate flood storage displacement volume for this example project are both demonstrated below. The results from using each methodology are similar but not in exact agreement. This is a function of the resolution provided by the number and spacing of the cross-sections in the Average End Area Method verses the number and size of the grids used in the Grid Method. The accuracy of the results will increase with the number of cross-sections or grids that are utilized. While the Department does not mandate an appropriate number of cross-sections or grids for a given site, the number of cross-sections or grids included in any analysis must be at least the minimum necessary to accurately reflect the topographic variations on site in both the existing and proposed conditions.

The Average End Area Method Example

To use the Average End Area Method for the example project described above, a series of 11 cross-sections were taken through the property shown in Figure 5.8, beginning with cross-section 1 on the westerly property line and ending with cross-section 11 on the easterly property line. These cross-sections are provided in Appendix G of this manual. Because many of the cross-sections are located at an interface (as described in consideration 4 in Section 5.3.1), these sections will differ depending on whether they are looking west or east. For instance, cross-section 2W is located just outside of the building, and cross-section 2E is located just inside of the building. The average area and volume for each cross-section were calculated for both existing and proposed conditions, reflected below in Figure 5.9 for the 10-year flood and in Figure 5.10 for the flood hazard area design flood.

As shown in Figure 5.9 on the next page, the total existing flood storage is 10,437 cubic feet while the proposed flood storage is 9,697 cubic feet for the 10-year flood. Therefore, the flood storage volume displacement (net fill) is 740 cubic feet or 7.1 percent of the 10-year flood storage volume, and the project satisfies the onsite 20 percent flood storage volume displacement requirements of N.J.A.C. 7:13-11.4 for the 10-year flood (see Section 5.2).

However, the FHACA Rules also require that the regulated activity will displace no more than 20 percent of the storage volume between the flood hazard area design flood and the 10-year flood, as explained in Section 5.2.1. As shown in Figure 5.10 on page 122, the total existing flood storage is 39,799.5 (39,800) cubic feet while the proposed flood storage is 36,510.9 (36,511) cubic feet for the flood hazard area design flood.

The existing flood storage in this zone would be:

$39{,}800\ ft^3 - 10{,}437\ ft^3 = 29{,}363\ ft^3$

The proposed flood storage in this zone would be:

$36{,}511\ ft^3 - 9{,}697\ ft^3 = 26{,}814\ ft^3$

This represents a flood storage displacement of 2,549 cubic feet or 8.7 percent in this zone, which would satisfy the 20 percent flood storage volume displacement requirements for both the 10-year flood and the volume between the 10-year and flood hazard area design floods. However, since there is a proposed loss of flood storage volume in both zones, the project would have to be redesigned to balance cut and fill onsite or else offsite compensation would have to be provided for the excess fill to satisfy the zero-percent flood storage displacement provisions of N.J.A.C. 7:13-11.4.

Figure 5.9: Flood Fringe Storage Volume for the 10-Year Flood (Average End Area Method)

10-Year Flood Elevation 21.5 NAVD

Existing

	Area (ft^2)	Average Area (ft^2)	Volume (ft^3)
Section 1	16.2		
		17.8	356
Section 2	19.4		
		23.1	462
Section 3	26.8		
		29.9	598
Section 4	33		
		37.875	757.5
Section 5	42.75		
		46.875	937.5
Section 6	51		
		54.75	1095
Section 7	58.5		
		63.65	1273
Section 8	68.8		
		73.55	1471
Section 9	78.3		
		82.35	1647
Section 10	86.4		
		92	1840
Section 11	97.6		
Existing Storage Volume (ft^3)			**10437**

Proposed

	Area (ft^2)	Average Area (ft^2)	Volume (ft^3)
Section 1	16.2		
		17.8	356
Section 2	19.4		
		23.1	462
Section 3	26.8		
		29.9	598
Section 4W	33		
Section 4E	17		
		17.5	350
Section 5	18		
		51.25	1025
Section 6	84.5		
		56.15	1123
Section 7	27.8		
		28.3	566
Section 8W	28.8		
Section 8E	79		
		82.5	1650
Section 9	86		
		88.75	1775
Section 10W	91.5		
Section 10E	86.9		
		92.25	1845
Section 11	97.6		
Storage Volume w/ Walls (ft^3)			**9750**
Walls (ft^3)			-53
Proposed Storage Volume (ft^3)			**9697**

Figure 5.10: Flood Fringe Storage Volume for the Flood Hazard Area Design Flood (Average End Area Method)

Design Flood Elevation 23.5 NAVD

Existing

	Area (ft^2)	**Average Area (ft^2)**	**Volume (ft^3)**
Section 1	115		
		122.45	2449
Section 2	129.9		
		137.45	2749
Section 3	145		
		152.5	3050
Section 4	160		
		168	3360
Section 5	176		
		187.9	3758
Section 6	199.8		
		207.7	4154
Section 7	215.6		
		224.05	4481
Section 8	232.5		
		244.2	4884
Section 9	255.9		
		264.05	5281
Section 10	272.2		
		281.675	5633.5
Section 11	291.15		
Existing Storage Volume (ft^3)			**39799.5**

Proposed

	Area (ft^2)	**Average Area (ft^2)**	**Volume (ft^3)**
Section 1	115		
		122.45	2449
Section 2W	129.9		
Section 2E	149		
		153.5375	3070.75
Section 3	158.075		
		165.9575	3319.15
Section 4W	173.84		
Section 4E	94.25		
		95.05	1901
Section 5W	95.85		
Section 5E	89.35		
		172.05	3441
Section 6	254.75		
		186.625	3732.5
Section 7W	118.5		
Section 7E	138		
		137.6	2752
Section 8W	137.2		
Section 8E	250.2		
		259.55	5191
Section 9	268.9		
		274.8	5496
Section 10W	280.7		
Section 10E	272.7		
		281.925	5638.5
Section 11	291.15		
Storage Volume w/ Walls (ft^3)			36990.9
Walls (ft^3)			-480
Proposed Storage Volume (ft^3)			**36510.9**

The Grid Method Example

To use the Grid Method for the example project described above, the project site was divided up into a grid comprised of 20-foot by 20-foot cells (see Figure 5.8). The vertical axis for the grid is represented by the letters A through G, and the horizontal axis of the grid is represented by the numbers 1 through 10. For the proposed conditions, depending on whether the 10-year flood or the flood hazard area design flood is being calculated, cells E2, E3, E4, E7, E8, and E9 were divided in half to form proposed 10-foot by 20-foot cells labeled "E" and "EE" to account for the fact that half of the cells are located within the footprint of each building and half are located outside of each building.

In Figure 5.11 on the next page and Figure 5.12 on pages 125-126, the cells E2, E4, E7, E8, and E9 represent the portions of the grid located within the footprint of each building (crawl space), whereas cells EE2, EE3, EE4, EE7, EE8, and EE9 represent the remaining portions of those cells located outside of each building (also labeled in red on Figure 5.9). While each cell measures 20 feet by 20 feet, the size of cells EE3, EE4, EE7, EE8, F3, F4, F7, F8, G3, G4, G7, and G8 differ in the proposed condition to account for the proposed one-foot wide retaining walls on either side of each driveway. Therefore, the grid sizes for EE3, F3, G3, EE8, F8, and G8 are slightly reduced, and those for EE4, F4, G4, EE7, G7, and G8 are slightly expanded.

Existing and proposed spot elevations are generally noted at the corner of each grid. However, proposed spots are not noted where there is no proposed grading, and no spot elevations are noted for areas located outside of the flood hazard area. As described in Section 5.3.2 above, the spot elevations for existing and proposed conditions have been averaged for the four corners of the rectangular cells and have been determined by inspection for triangular and trapezoidal areas or for areas where grading is irregular. The average elevation, average flood depth, area, and volume for each cell were then calculated for both existing and proposed conditions. This information is reflected in Figure 5.11 for the 10-year flood and in Figure 5.12 for the flood hazard area design flood.

As shown in Figure 5.11, the total existing flood storage is 10,434 cubic feet while the proposed flood storage is 9,770 cubic feet for the 10-year flood. This represents a flood storage volume displacement of 664 cubic feet or 6.4 percent. The project satisfies the onsite 20-percent flood storage displacement limitations of N.J.A.C. 7:13-11.4 for the 10-year flood (as explained in Section 5.2).

However, the rules also require that the regulated activity displace no more than 20 percent of the storage volume between the flood hazard design flood and the 10-year flood (see Section 5.2.1). As shown in Figure 5.12, the total existing flood storage is 39,637 cubic feet while the proposed flood storage is 36,693 cubic feet for the flood hazard area design flood.

The existing flood storage in this zone would be:	39,637 ft^3 - 10,434 ft^3 = 29,203 ft^3
The proposed flood storage in this zone would be:	36,693 ft^3 - 9,770 ft^3 = 26,923 ft^3

Figure 5.11: Flood Fringe Storage Volume for the 10-Year Flood (Grid Method)

10-Year Flood Elevation 21.5 NAVD

Existing

Grid	Average Elevation	Depth (ft)	Area (ft²)	Volume (ft³)
D8&E 8	21.0	0.5	422	211
D9	21.3	0.2	115	23
D10	21.2	0.3	205	62
E4	21.4	0.1	25	3
E5	21.3	0.2	150	30
E6	21.2	0.3	240	72
E7	21.1	0.4	325	130
E9	20.8	0.7	400	280
E10	20.7	0.8	400	320
F1	21.3	0.2	185	37
F2	21.2	0.3	275	83
F3	21.1	0.4	360	144
F4	21.0	0.5	400	200
F5	20.8	0.7	400	280
F6	20.6	0.9	400	360
F7	20.4	1.1	400	440
F8	20.2	1.3	400	520
F9	20.1	1.4	400	560
F10	20.0	1.5	400	600
G1	20.7	0.8	400	320
G2	20.5	1.0	400	400
G3	20.3	1.2	400	480
G4	20.2	1.3	400	520
G5	20.0	1.5	400	600
G6	19.9	1.6	400	640
G7	19.7	1.8	400	720
G8	19.6	1.9	400	760
G9	19.5	2.0	400	800
G10	19.4	2.1	400	840
			Total:	**10434**

Proposed

Grid	Average Elevation	Depth (ft)	Area (ft²)	Volume (ft³)
D5	21.3	0.2	50	10
D6	21.2	0.3	50	15
D7	Cr Space	0.4	200	80
D8	Cr Space	0.4	400	160
D9	Cr Space	0.4	400	160
D10	21.2	0.3	205	62
E5	20.8	0.7	180	126
E6	20.8	0.7	180	126
E8	Cr Space	0.4	200	80
EE8	20.8	0.7	190	133
E9	Cr Space	0.4	200	80
EE9	20.6	0.9	200	180
E10	20.7	0.8	400	320
F1	21.4	0.1	185	19
F2	21.3	0.2	275	55
F3	21.2	0.3	340	102
F5	20.6	0.9	303	273
F6	20.5	1.0	350	350
F7	21.2	0.3	147	44
F8	20.2	1.3	380	494
F9	20.1	1.4	400	560
F10	20.0	1.5	400	600
G1	20.7	0.8	400	320
G2	20.5	1.0	400	400
G3	20.3	1.2	395	474
G4	20.6	0.9	405	365
G5	19.9	1.6	400	640
G6	19.8	1.7	400	680
G7	20.2	1.3	405	527
G8	19.6	1.9	395	751
G9	19.5	2.0	400	800
G10	19.4	2.1	400	840
Internal Walls (ft³):				-53
Total:				**9770**

Figure 5.12: Flood Fringe Storage Volume for the Flood Hazard Area Design Flood (Grid Method)

Design Flood Elevation 23.5 NAVD

Existing					Proposed				
Grid	Av Elev	Depth (ft)	Area (ft^2)	Volume (ft^3)	Grid	Av Elev	Depth (ft)	Area (ft^2)	Volume (ft^3)
A10&B10	23.1	0.4	410	164	A10&B10	23.1	0.4	410	164
B6&C6	23.0	0.5	385	193	B6&C6	23.0	0.5	385	193
B7	23.4	0.1	90	9	B7	23.4	0.1	90	9
B8	23.3	0.2	195	39	B8	23.3	0.2	195	39
B9	23.2	0.3	305	92	B9	23.2	0.3	305	92
C3	23.4	0.1	70	7	C3	23.4	0.1	70	7
C4	23.3	0.2	175	35	C4	23.3	0.2	175	35
C5	23.2	0.3	280	84	C5	23.1	0.4	280	112
C7	22.9	0.6	400	240	C7	22.9	0.6	400	240
C8	22.7	0.8	400	320	C8	22.8	0.7	400	280
C9	22.5	1.0	400	400	C9	22.5	1.0	400	400
C10	22.3	1.2	400	480	C10	22.3	1.2	400	470
D1	23.2	0.3	250	75	D1	23.2	0.3	250	75
D2	23.1	0.4	350	140	D2	Cr Space	1.2	400	480
D3	22.9	0.6	400	240	D3	Cr Space	1.2	400	480
D4	22.6	0.9	400	360	D4	Cr Space	1.2	200	240
D5	22.4	1.1	400	440	D5	22.3	1.2	400	480
D6	22.2	1.3	400	520	D6	22.3	1.2	400	480
D7	22.1	1.4	400	560	D7	Cr Space	2.4	200	480
D8	21.9	1.6	400	640	D8	Cr Space	2.4	400	960
D9	21.7	1.8	400	720	D9	Cr Space	2.4	400	960
D10	21.5	2.0	400	800	D10	21.5	2.0	400	800
E1	22.4	1.1	400	440	E1	22.4	1.1	400	440
E2	22.2	1.3	400	520	E2	Cr Space	1.2	200	240
E3	22.0	1.5	400	600	EE2	22.0	1.5	200	300
E4	21.8	1.7	400	680	E3	Cr Space	1.2	200	240
E5	21.6	1.9	400	760	EE3	21.8	1.7	190	323
E6	21.4	2.1	400	840	EE4	23.4	0.1	210	21
E7	21.3	2.2	400	880	E5	21.8	1.7	400	680
E8	21.0	2.5	400	1000	E6	21.7	1.8	400	720
E9	20.8	2.7	400	1080	EE7	23.2	0.3	210	63
E10	20.7	2.8	400	1120	E8	Cr Space	2.4	200	480
F1	21.6	1.9	400	760	EE8	20.8	2.7	190	513

F2	21.4	2.1	400	840
F3	21.2	2.3	400	920
F4	21.0	2.5	400	1000
F5	20.8	2.7	400	1080
F6	20.6	2.9	400	1160
F7	20.4	3.1	400	1240
F8	20.2	3.3	400	1320
F9	20.1	3.4	400	1360
F10	20.0	3.5	400	1400
G1	20.7	2.8	400	1120
G2	20.5	3.0	400	1200
G3	20.3	3.2	400	1280
G4	20.2	3.3	400	1320
G5	20.0	3.5	400	1400
G6	19.9	3.6	400	1440
G7	19.7	3.8	400	1520
G8	19.6	3.9	400	1560
G9	19.5	4.0	400	1600
G10	19.4	4.1	400	1640
			Total:	**39637**

E9	Cr Space	2.4	200	480
EE9	20.6	2.9	200	580
E10	20.7	2.8	400	1120
F1	21.6	1.9	400	760
F2	21.4	2.1	400	840
F3	21.2	2.3	380	874
F4	22.4	1.1	420	462
F5	21.0	2.5	400	1000
F6	20.8	2.7	400	1080
F7	21.9	1.6	420	672
F8	20.2	3.3	380	1254
F9	20.1	3.4	400	1360
F10	20.0	3.5	400	1400
G1	20.7	2.8	400	1120
G2	20.5	3.0	400	1200
G3	20.3	3.2	395	1264
G4	20.6	2.9	405	1175
G5	19.9	3.6	400	1440
G6	19.8	3.7	400	1480
G7	20.2	3.3	405	1337
G8	19.6	3.9	395	1541
G9	19.5	4.0	400	1600
G10	19.4	4.1	400	1640
Internal Walls (ft^3):				-480
Total:				**36693**

This would represent a flood storage displacement of 2,280 cubic feet or 7.8 percent in this zone, which would satisfy the 20 percent flood storage volume displacement requirements for both the 10-year flood and the volume between the 10-year and flood hazard area design floods. However, since there is a loss of flood storage volume proposed in both zones, the project would have to be redesigned to balance cut and fill onsite, or offsite compensation would have to be provided for the excess fill to satisfy the flood storage volume displacement provisions of N.J.A.C. 7:13-11.4.

5.5 Engineering Report and Drawing Requirements

As mentioned in Section 3.3.2 of this manual, an engineering report and drawings signed and sealed by a New Jersey licensed professional engineering must be submitted to the Department when a project requires analysis of flood storage volume displacement and compensation. The submission requirements depend on which method was used to calculate flood storage – the Average End Area Method (explained in Section 5.3.1), the Grid Method (explained in Section 5.3.2), or the TIN Method (explained in Section 5.3.3). The report and drawing requirements for both the Average End Area Method and the Grid Method are provided below. For submission requirements for the TIN Method, please contact the Department.

The Average End Area Method Requirements

When the Average End Area Method is utilized, cross-sections must be provided on signed and sealed drawings. Their locations must be shown in plan view on a location plan that must also depict the baseline from which all station and elevation information is presented within a given cross-section. If the floodway exists on the site, it must also be shown on the location plan.

Existing and proposed topography must be shown in both plan view and cross-sectional view. They may be shown on the same plan view and cross-section, provided the scale is such that the information remains legible. In most cases, it is preferable to overlay existing and proposed topography so the Department and any other interested party may verify the difference in topography used in the calculations associated with a proposed condition more quickly.

Existing and proposed topography must be shown in both plan view and cross-sectional view.

The number and location of cross-sections required to reasonably quantify the existing and proposed flood storage volumes on site are at the discretion of the design engineer but must sufficiently describe the topographic variation that occurs on a site in both the existing condition and the proposed condition. Cross-sections must also capture all existing and proposed structures.

As mentioned, all cross-sections must be legible. To ensure maximum legibility, the horizontal scale should not exceed 1″ = 20′ and the vertical scale should not exceed 1″ = 5′. On each plotted cross-section, a line must be drawn to indicate both the 10-year flood elevation and the flood hazard area design flood elevation. The floodway location must also be depicted on any cross-section that contains it. Lines of different weight must be used to distinguish between the 10-year and flood hazard area design flood elevations as well as existing and proposed topography.

The engineering report must contain a tabular calculation of the proposed volumetric modifications on a given site. This calculation must contain the existing and proposed flood fringe storage volumes for each cross-section as well as the overall flood fringe storage volume for the 10-year flood and flood hazard area design flood for both the existing and proposed conditions. These computations may also be placed directly on signed and sealed engineering drawings.

The Grid Method Requirements

When the grid method is used, the engineering drawings must show an overlay of the grid network on the existing condition and the proposed condition. Unlike the Average End Area Method, applicants should avoid overlaying existing and proposed conditions on the same grid to maintain legibility. Each grid should be of a size representative of the area being modeled. While the size of the grid is at the discretion of the design professional, grids are typically no greater than 25 feet by 25 feet, with size driven by variations in existing and proposed grade onsite. The existing and proposed elevations at each corner of each grid and the average depth of flooding in the grid must be shown in the drawings.

The engineering report must contain a tabular calculation of the proposed volumetric modifications on a given site. This calculation must contain the existing and proposed flood fringe storage volumes for each grid as well as the overall flood fringe storage volume for the 10-year flood and flood hazard area design flood for both the existing and proposed conditions. These computations may also be placed directly on signed and sealed engineering drawings.

SECTION 6 RIPARIAN ZONES

As mentioned in Section 2.2, healthy riparian zones serve many important functions, and adequately preserving these areas is essential to protect against flooding as well as to protect New Jersey's natural resources and water supply. For these reasons, riparian zones are a regulated area under the FHACA Rules.

Regardless of a water's drainage area, all regulated waters (as defined in Section 2.1) have a riparian zone except for the following:

- **The Atlantic Ocean**
- **New Jersey's barrier island complex, as defined at N.J.AC. 7:13-1.2**
- **A lawfully existing manmade lagoon, most of which were created in coastal areas for residential development**
- **A lawfully existing stormwater management basin or wastewater treatment pond**
- **A segment of a regulated water enclosed within a lawfully existing pipe, culvert, or bridge**
- **A lawfully existing, manmade open channel that was created to convey stormwater, provided the channel is fully lined with manmade impervious material, such as a concrete low-flow channel within a stormwater basin or a ditch completely lined with concrete or asphalt**

The Department can decide whether a regulated water requires an associated riparian zone through an applicability determination. Please refer to Section 2.5 of this technical manual for more information on applicability determinations.

The riparian zone includes the land and vegetation both within the regulated water and within either 50 feet, 150 feet, or 300 feet from the top of bank along both sides of the regulated water. Section 6.1, below, explains how to determine the width of the riparian zone while Section 6.2 provides instruction for determining top of bank.

Determining the limits of the riparian zone can be complicated by certain situations, such as when a portion of a water possesses a riparian zone while another portion of the same water does not. Section 6.3 addresses how to apply the riparian zone in some of these situations, such as in headwaters and coastal wetlands.

Since riparian zones are a regulated area under the FHACA Rules, specific requirements apply whenever a regulated activity occurs within the riparian zone, and those requirements are discussed in Section 6.4. Section 6.5 discusses buffers and transition areas under other regulations.

6.1 Determining the Width of the Riparian Zone

As previously mentioned, the width of the riparian zone along each regulated water will be either 300 feet, 150 feet, or 50 feet. The 300-foot riparian zone is described in Section 6.1.1 while the 150-foot riparian zone is described in Section 6.1.2. The 50-foot riparian zone applies along all waters that do not have either a 300-foot or 150-foot riparian zone.

The Department can make a determination regarding the extent of the riparian zone on a project site under a flood hazard area verification as described at N.J.A.C. 7:13-5. For more information on verifications, please refer to Section 3.2 of this technical manual.

6.1.1 The 300-Foot Riparian Zone

The riparian zone is 300 feet wide along both sides of any Category One water and all regulated upstream tributaries situated within the same HUC-14 subwatershed as that Category One water. *Category One* is a stream classification applied to waters with exceptional ecological significance, recreational significance, water supply significance, or fisheries resources that are therefore protected from any measurable change in water quality. A *HUC-14* is a hydrologic unit code consisting of 14 numbers that is used to identify the boundaries of each drainage basin in New Jersey.

The Department maintains a list of stream classifications within its Surface Water Quality Standards at N.J.A.C. 7:9B. Streams, lakes, and reservoirs that have been designated as Category One are specifically listed. The Department has developed mapping showing HUC-14 areas and Category One streams, which is available on the Department's interactive mapping tool found at http://www.nj.gov/dep/gis/geowebsplash.htm, to aid in making a determination on whether a project is located in an area of the State where the 300-foot riparian zone might apply under the FHACA Rules. However, if there is a conflict, the listing in the Department's Surface Water Quality Standards will govern. In some cases, the Category One stream layer depicts the Category One designation extending just beyond (upstream) of the HUC-14 layer as shown in Figure 6.1 on the next page. In these situations, the Department will consider the HUC-14 boundary line to be the limit of the Category One designation. It is not the Department's intention to expand the Category One designation to the entire upper watershed when these minor variations exist.

Figure 6.1: Determining the Limit of a Category One Designation Near a HUC-14 Boundary Line

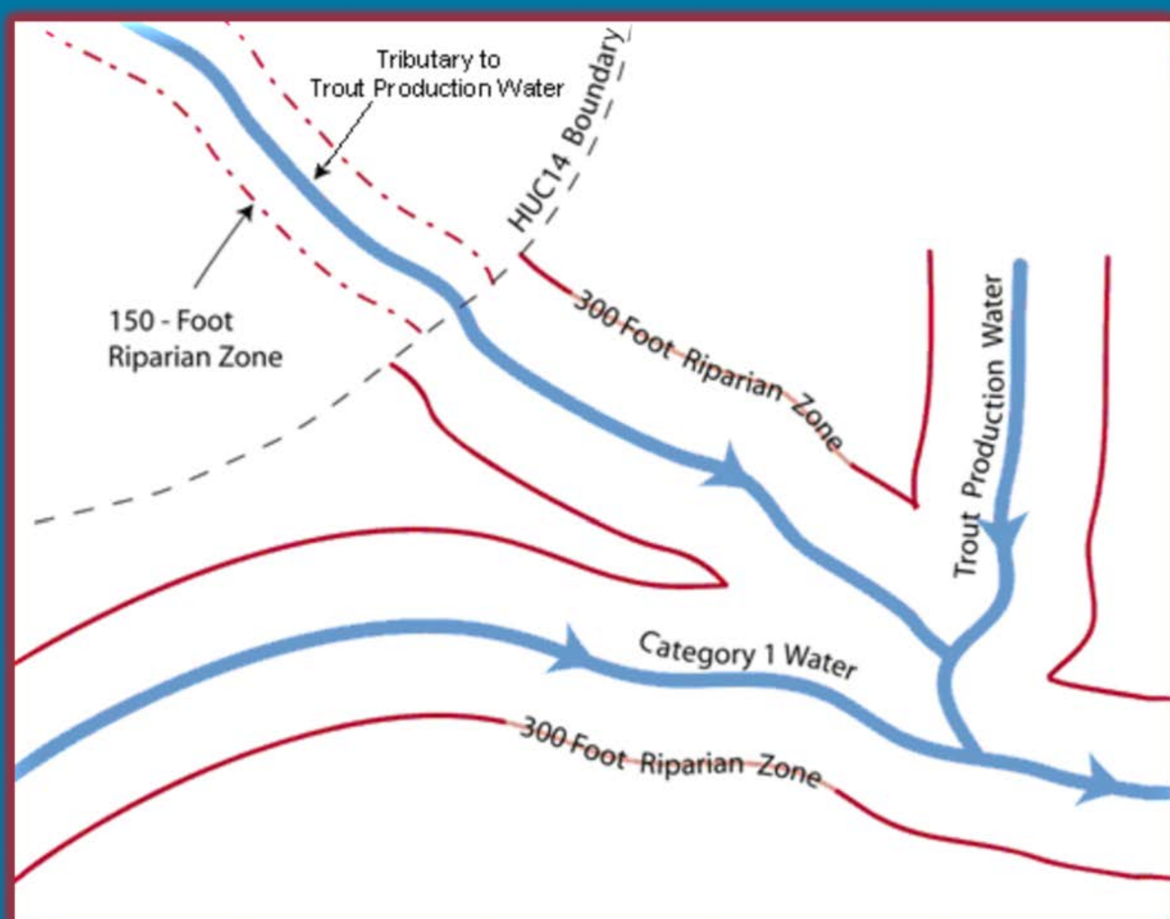
6.1.2 The 150-Foot Riparian Zone

The riparian zone is 150 feet wide along both sides of any waters containing trout resources, including both trout production and trout maintenance, and certain threatened or endangered species of plant or animal – unless the regulated water otherwise qualifies for a 300-foot riparian zone.

Trout Production Waters

The FHACA Rules establish a 150-foot riparian zone along trout production waters and all upstream waters (including tributaries). Most trout production waters in the State are also designated as Category One waters. Since Category One waters and tributaries within the same HUC-14 watershed receive a 300-foot riparian zone (see Section 6.1.1 above), the 300-foot riparian zone would govern in cases where a trout production water is also a Category One water. However, any tributary to a trout production water outside the HUC-14 boundary of the Category One designation would receive a 150-foot riparian zone up to its source, as shown in Figure 6.2 below.

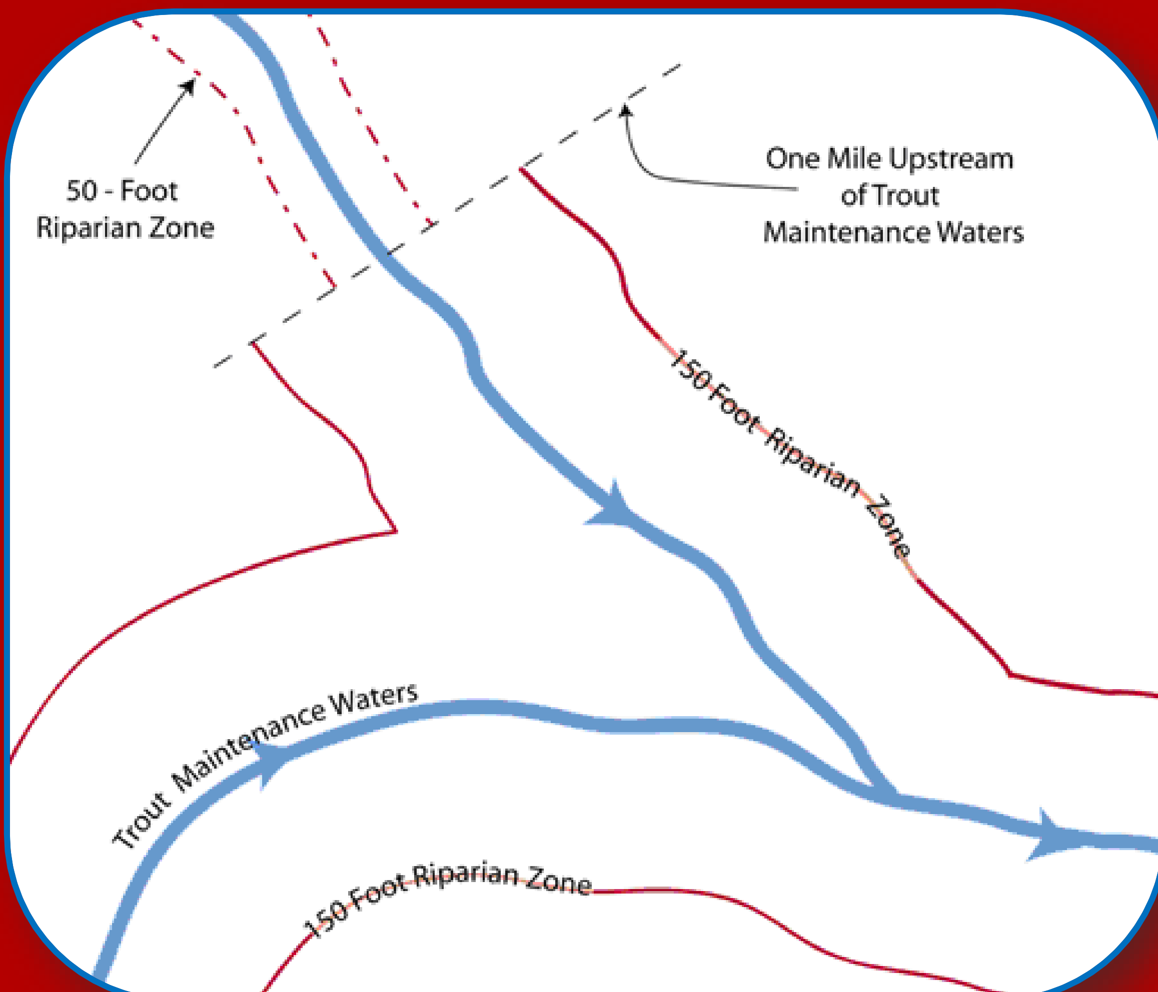
Figure 6.2: The Riparian Zone for Tributaries to Trout Production Waters



Trout Maintenance Waters

The riparian zone is also 150 feet wide along both sides of any trout maintenance water and all upstream waters (including tributaries) within one linear mile as measured along the length of the regulated water. Thus, the one mile upstream follows the sinuosity of the stream and its tributaries, meaning it follows their natural curves or bends and is not a straight line. (See Figure 6.3 below.)

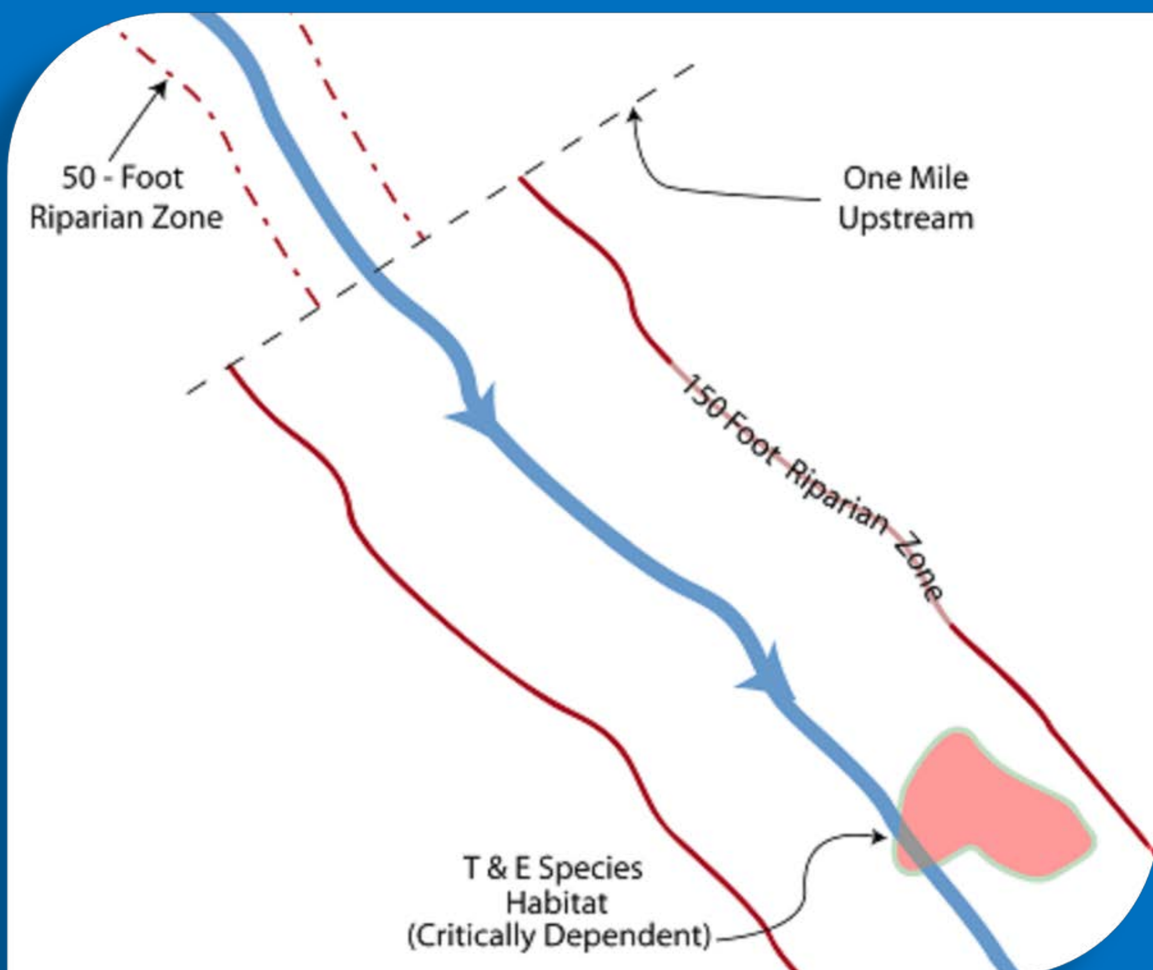
Figure 6.3: The Riparian Zone for Tributaries to Trout Maintenance Waters



Threatened and Endangered Species

Finally, the 150-foot riparian zone applies to any segment of regulated waters flowing through an area that contains a threatened or endangered species and/or present or documented habitat for such a species, provided the species is critically dependent on the regulated water for survival. The 150-foot riparian zone also applies to all upstream waters (including tributaries) located within one mile of such habitat (measured along the length of the regulated water). Similar to trout maintenance waters, the one mile upstream is measured by stream miles, following the sinuosity (or natural curves or bends) of the stream and its tributaries and is not a straight line, as shown in Figure 6.4 below. See Section 8.2 for a discussion of the 150-foot riparian zone as it applies to threatened and endangered species.

Figure 6.4: The Riparian Zone for Tributaries to Waters with Critically Dependent Threatened or Endangered Species Habitat

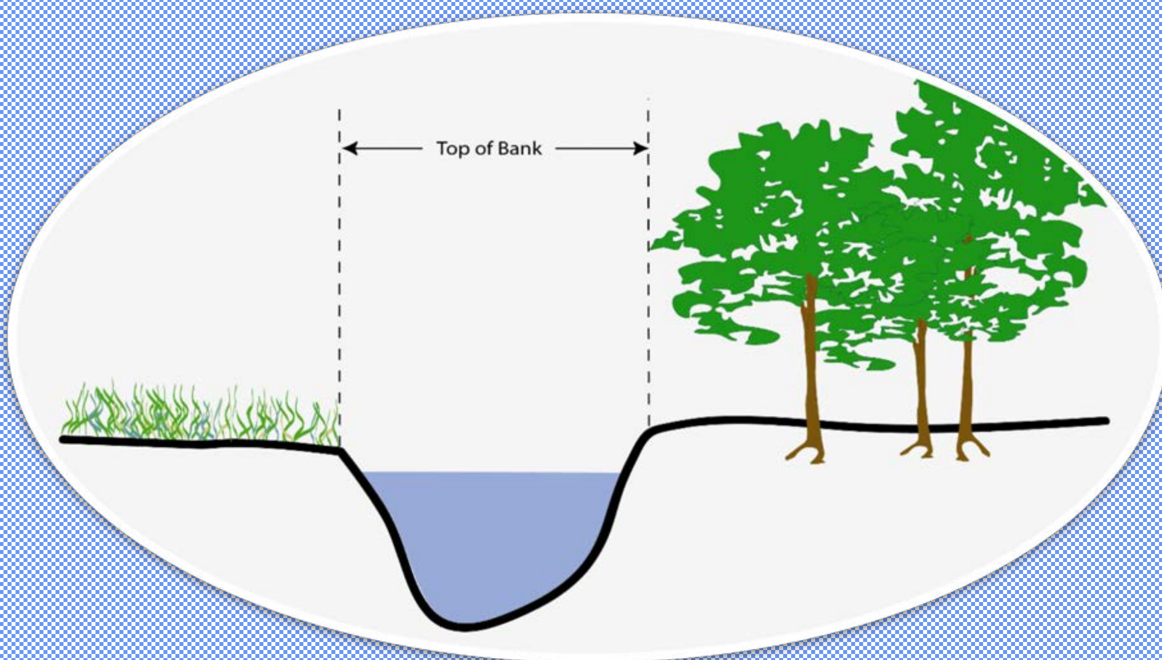


6.2 Determining Top of Bank

The width of the riparian zone is measured from the top of bank. The FHACA Rules at N.J.A.C. 7:13-1.2 define *top of bank* as "the upper limit of the bank of a regulated water, which is typically characterized by an observable change or break in the slope of the land." *Bank* is defined as "the inclined side of a channel, an excavated or impounded area or a topographic depression, which confines and/or conducts water." Since the bank is actually part of the channel, the top of bank cannot be outside or beyond the channel itself. *Channel* is defined as a "linear topographic depression that continuously or intermittently confines and/or conducts surface water, not including transient erosional gullies and other ephemeral features that temporarily form after heavy rainfall. A channel can be naturally occurring or can be of human origin through excavation or construction, in which case it is referred to as 'manmade.' A channel includes both bed and banks." The channel, therefore, conveys water on a regular or semi-regular basis and/or after a typical rainfall event and does not include the entirety of deep ravines, bluffs, or other large embankments or slopes that may lie adjacent to a channel. The terms *transient* and *ephemeral*, meaning to remain for only a brief time, refer to the presence of the channel itself and not the regularity with which water flows through the channel.

Along linear features (such as a stream or river), the top of bank is usually a well-defined break at the top of the slope where the channel ends. (See Figure 6.5 below.)

Figure 6.5: Typical Top of Bank for Linear Features



However, in some cases, it may be difficult to discern the precise location of the top of bank. In such instances, several methods can be utilized to determine top of bank, depending on the type of water. These methods are described below for the following types of waters:

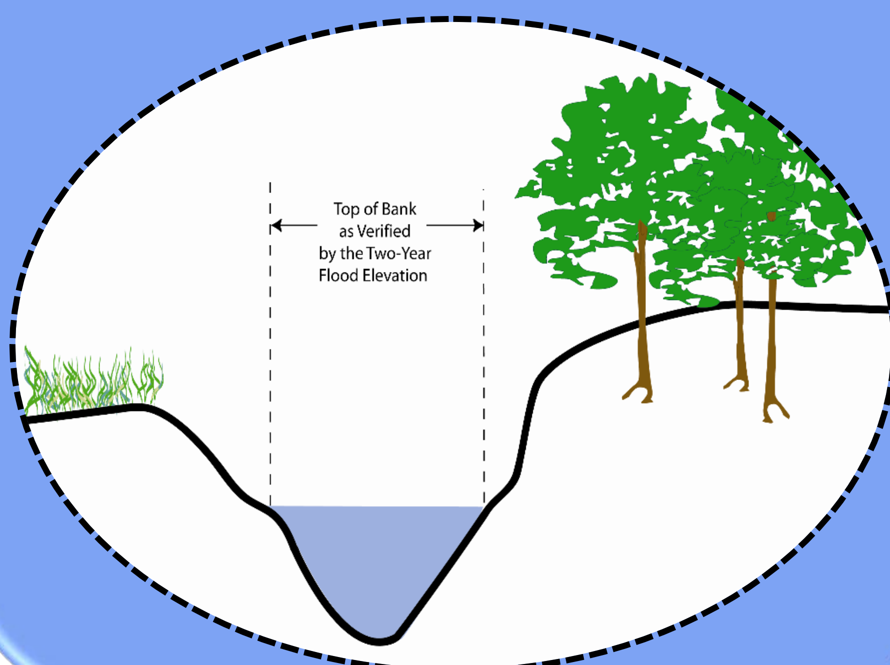
- Linear regulated waters draining 150 acres or more
- Linear regulated waters draining less than 150 acres
- Fluvial waters that contain water at all times
- Tidal waters
- Amorphous or irregularly shaped features

See Section 2.1.3 of this technical manual for information on how to determine the drainage area of a water.

Linear Regulated Waters Draining 150 Acres or More

In most cases, waters with a drainage area of 150 acres or more contain enough flow to create a channel. However, the channel itself may be difficult to distinguish from the surrounding landscape, especially when the water lies at the base of a steep ravine or bluff. For these types of waters, where the top of bank is not discernible, top of bank can be established at the depth of the two-year flood event, which can be determined utilizing hydraulic calculations, which are explained in Section 4.6 of this manual. Figure 6.6, at right, shows a diagram of this type of feature.

Figure 6.6: Top of Bank of a Linear Regulated Water Draining 150 Acres or More



Linear Regulated Waters Draining Less Than 150 Acres

For linear regulated waters with drainage areas of less than 150 acres but greater than 50 acres where the top of bank is not discernible, the feature's centerline is considered the top of bank. (See Figure 6.7 below.) Features with no defined banks and a drainage area of less than 50 acres are not regulated waters.

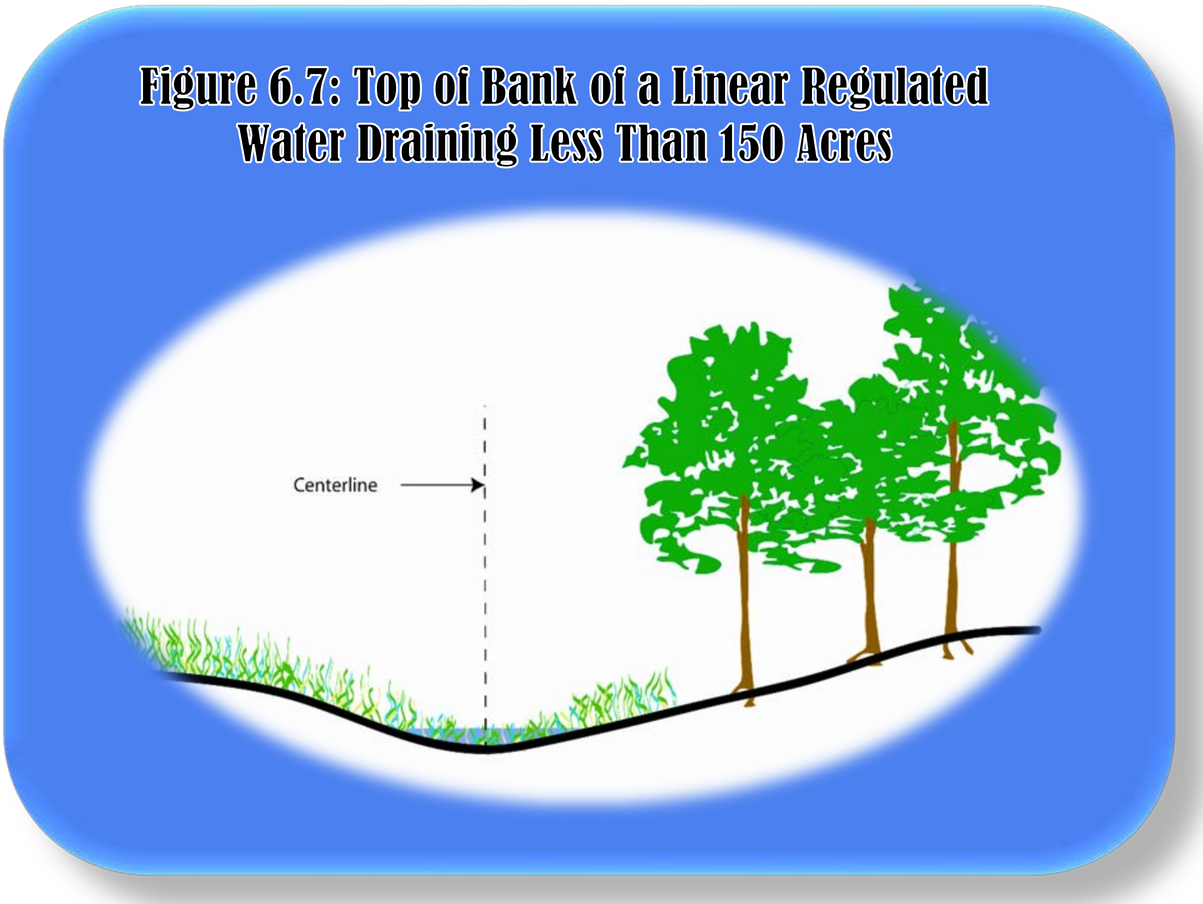


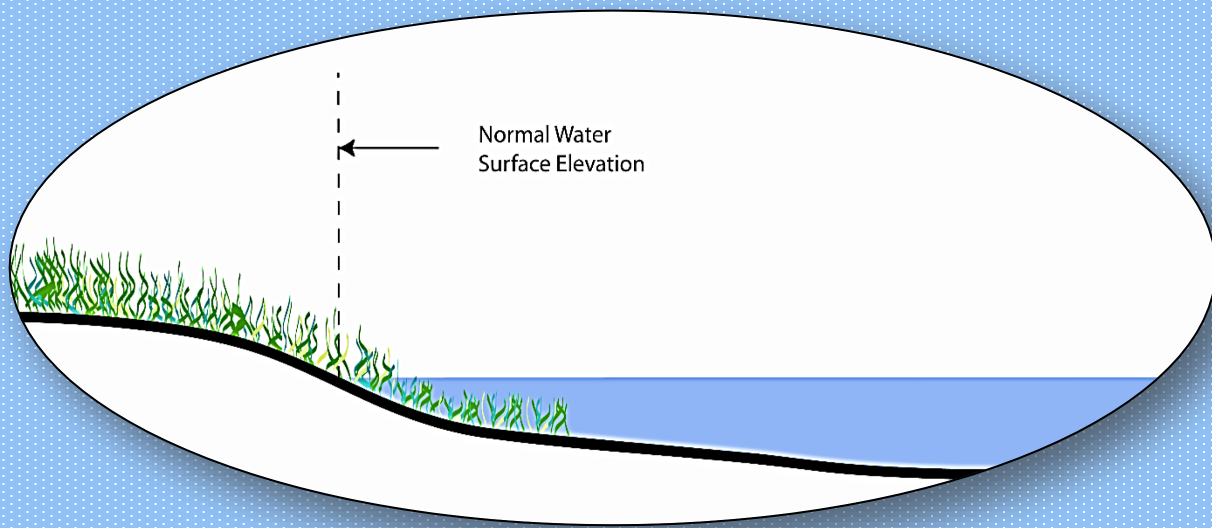
Figure 6.7: Top of Bank of a Linear Regulated Water Draining Less Than 150 Acres

Fluvial Waters that Contain Water at All Times

In cases where the regulated water is a linear, fluvial water with no discernible top of bank and a drainage area of 10 square miles or more, the normal water surface limit is considered the top of bank.

The normal water surface limit is also considered the top of bank along non-linear, fluvial regulated waters, such as lakes, ponds, and reservoirs, since it can be difficult to identify the top of bank along such large fluvial water bodies. (See Figure 6.8 on the following page.)

Figure 6.8: Top of Bank of a Fluvial Regulated Water Containing Water at All Times



Tidal Waters

In cases where there is no discernible top of bank along non-linear features in tidal areas, such as bays and inlets, the mean high water line will be considered the top of bank. (See Figure 6.9, below.)

Figure 6.9: Top of Bank of a Non-Linear Regulated Water in a Tidal Area

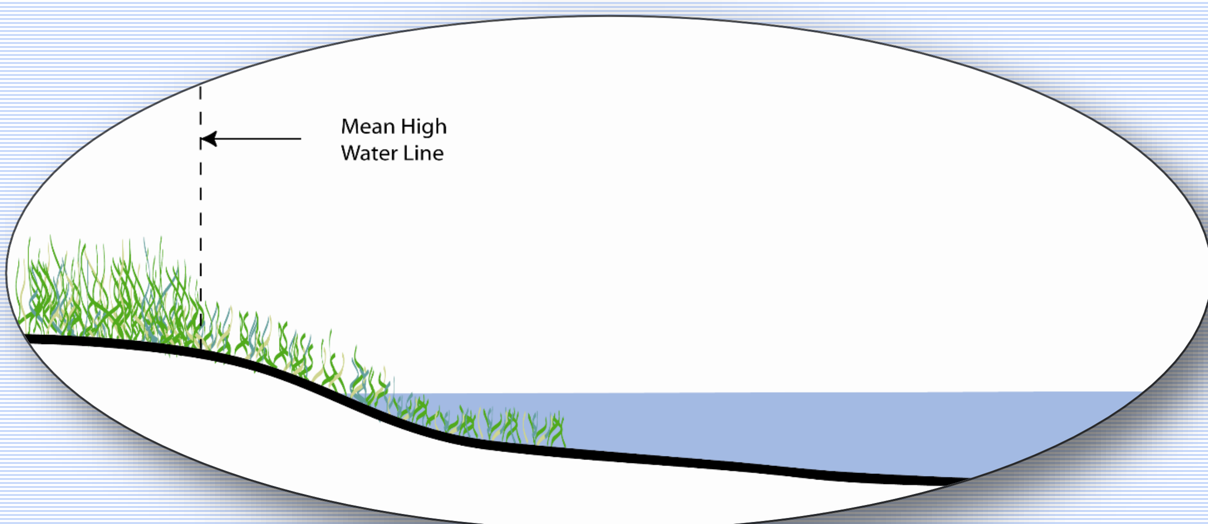


Figure 6.10, below, shows an example of a tidal creek and adjacent marsh at high tide while Figure 6.11 (adjacent to Figure 6.10) shows the same location at low tide. If there is no discernible top of bank at either high tide or low tide, the top of bank will be represented by the high tide (Figure 6.10). However, it is common for tidal creeks contained within a visible channel to frequently flood the adjacent marsh during normal or spring high tide events. Therefore, such a channel may only be visible at low tide. If the channel visible at low tide (Figure 6.11) has discernible top of banks, the Department will consider the channel limits to be the top of bank.

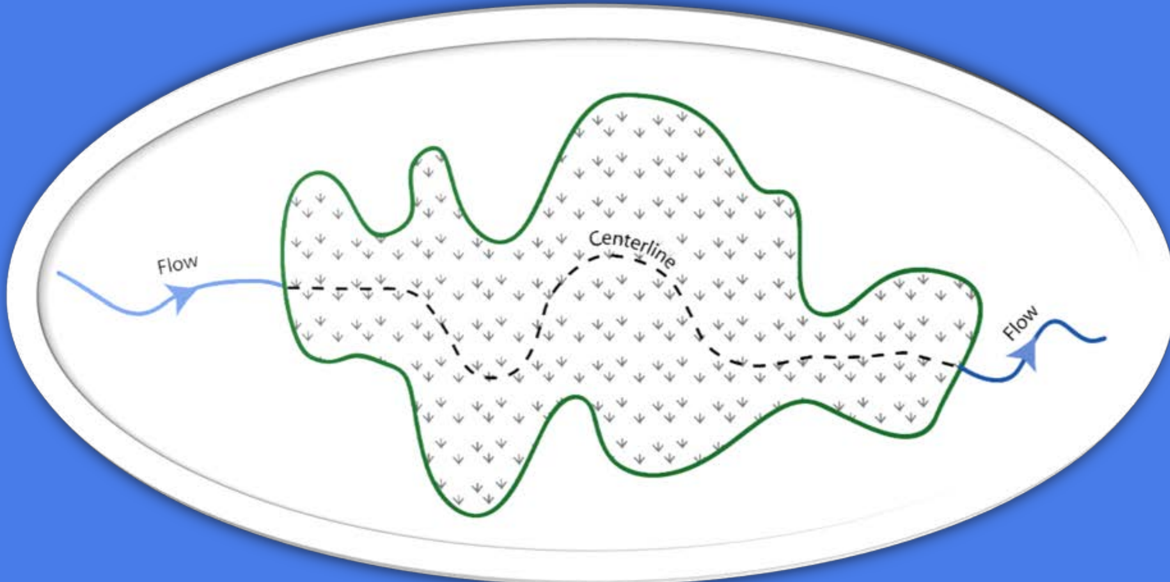
Figure 6.10: Top of Bank of Non-Linear Tidal Waters - A Tidal Creek at High Tide

Figure 6.11: Top of Bank of Non-Linear Tidal Waters - A Tidal Creek at Low Tide

Amorphous or Irregularly Shaped Features

Regulated waters sometimes flow through an amorphous or irregularly shaped feature, such as a wetland, that lacks a discernible channel for a certain distance. This can occur in both fluvial and tidal areas. In such cases, the feature's centerline is considered the top of bank. (See Figure 6.12 on the next page).

Figure 6.12: Top of Bank of a Regulated Water Flowing Through an Amorphous or Irregularly Shaped Feature



However, where a regulated water flows out of a feature such as a wetland and no regulated water lies within or upstream of the feature, the riparian zone would exist only downstream of the feature (see Figure 2.3 in Section 2 of this manual).

As noted previously in Section 2.1.1, N.J.A.C. 7:13-2.2(a)3 provides that certain features with a drainage area of less than 50 acres are not subject to the FHACA Rules, such as waters without a discernible channel. Such features do not possess a riparian zone. However, features that drain less than 50 acres and have a discernible channel are regulated. In some cases, a feature that drains less than 50 acres may possess a discernible channel for a particular reach but will not possess a discernible channel for a different reach. In such cases, only the portion of the feature that possesses a discernible channel and is connected to a regulated water downstream would constitute a regulated water because the upstream portion of the water, while possessing a discernible channel, is isolated. A riparian zone only exists around the portions of the water that are regulated. (See Figure 2.6 in Section 2.)

6.3 Applying the Riparian Zone

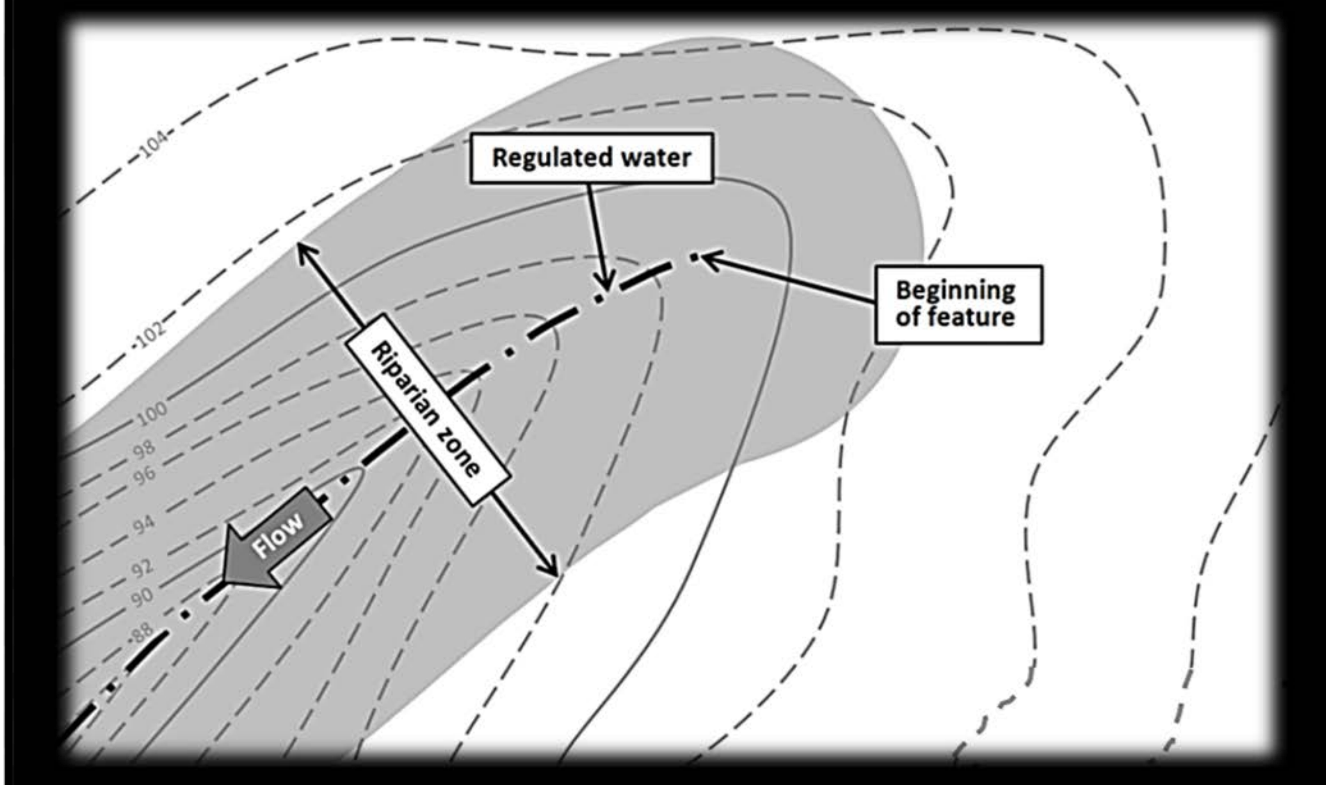
The riparian zone is often misapplied in certain common situations. At N.J.A.C. 7:13-4.1(d) through (h), the FHACA Rules provide guidance for properly applying the riparian zone in the following situations, each of which is illustrated below:

- Headwaters
- Roadways or railroads crossing over pipes, culverts, or bridges
- Regulated waters enclosed within pipes, culverts, or bridges that are not part of a roadway or railroad
- Excavated areas or impoundments filled with water
- Coastal Wetlands

Headwaters

Where a regulated water naturally forms, begins, or ends within a site, the riparian zone arcs around the end of the feature. In other words, where a headwater exists, the riparian zone arcs from the point of origin, which would be the point where a continuous, defined channel begins. (See Figure 6.13 below.)

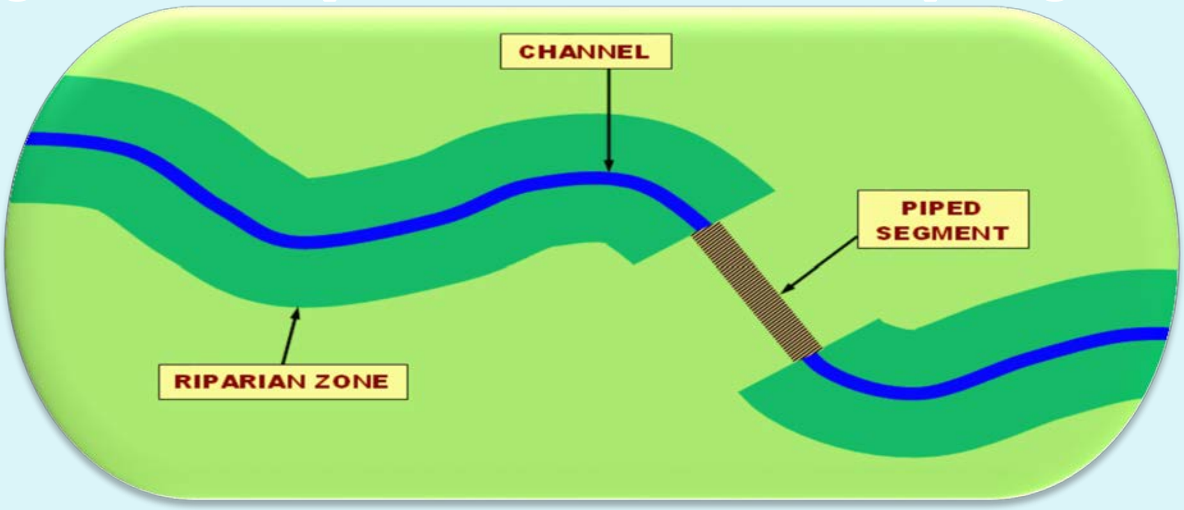
Figure 6.13: The Riparian Zone of a Headwater



Roadways or Railroads Crossing Over Pipes, Culverts, or Bridges

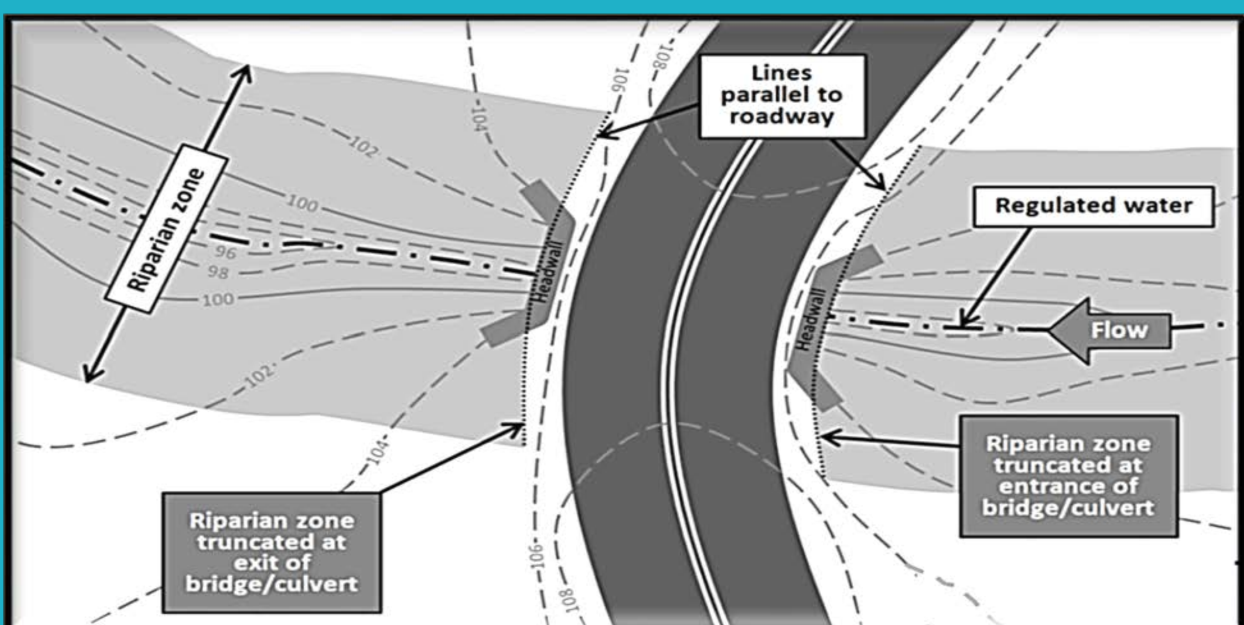
As previously mentioned, a segment of a regulated water enclosed within a lawfully existing pipe, culvert, or bridge does not have a riparian zone, as shown in Figure 6.14, below.

Figure 6.14: The Riparian Zone of a Water with a Piped Segment



Where a roadway or railroad crosses over a lawfully existing pipe, culvert, or bridge, the riparian zone is truncated at the entrance and exit of the structure. The lines of truncation run parallel to the direction of traffic and curve with the roadway so that the roadway is not located within the riparian zone, as shown in Figure 6.15, below.

Figure 6.15: The Riparian Zone Where a Roadway or Railroad Crosses Over a Pipe, Culvert, or Bridge



Regulated Waters Enclosed within Pipes, Culverts, or Bridges that are Not Part of a Roadway or Railroad

Where a regulated water enters or exits a lawfully existing pipe, culvert, or bridge that is not part of a roadway or railroad, the riparian zone is truncated at the entrance and exit of the structure at a straight line that runs perpendicular to the predominant direction of flow in the regulated water. (See Figure 6.16, below.)

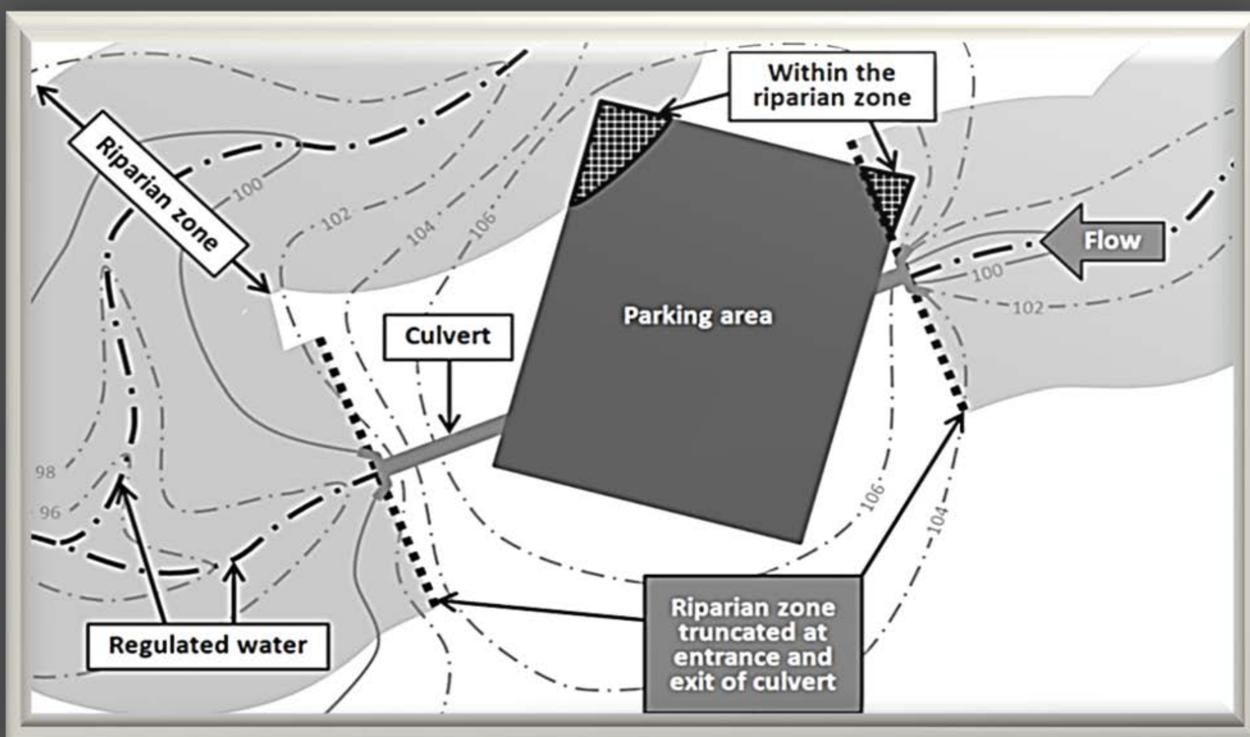
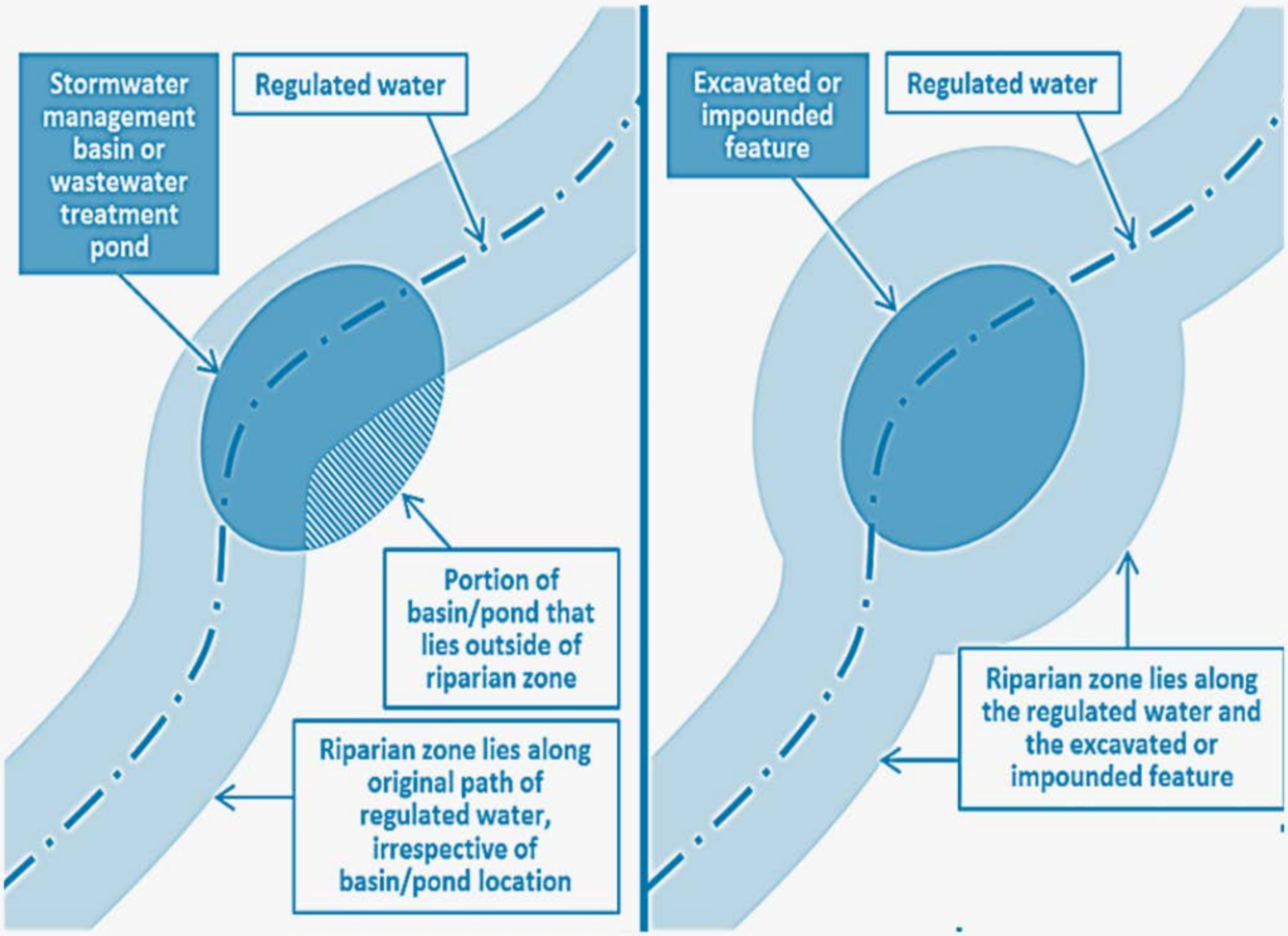


Figure 6.16: The Riparian Zone of a Regulated Water Entering or Exiting a Pipe, Culvert, or Bridge That is Not Part of a Roadway or Railroad

Excavated Areas or Impoundments Filled with Water

As shown in Figure 6.17 on the following page, where a lawfully existing excavated area or impoundment filled with water (such as an irrigation pond) lies along a regulated water, the riparian zone is measured outward from the top of bank of the excavated or impounded feature, with the exception of stormwater management basins and wastewater treatment ponds since these features do not have a riparian zone. In the case of stormwater management basins and wastewater treatment ponds, the riparian zone lies along the original path of the regulated water, irrespective of the location of the basin or pond.

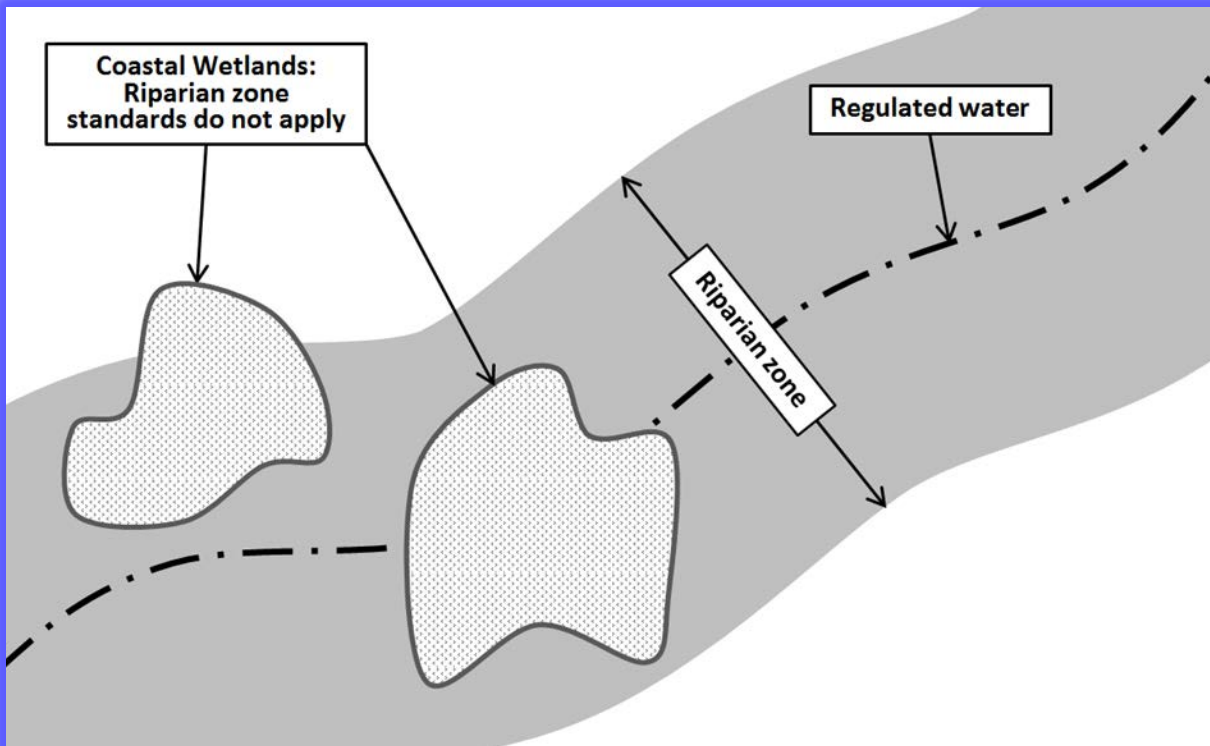
Figure 6.17: The Riparian Zone Where an Excavated Area or Impoundment Filled with Water Lies Along a Regulated Water



Coastal Wetlands

When a regulated water flows through a coastal wetland regulated under the Wetlands Act of 1970, the riparian zone standards do not apply within the wetland since coastal wetlands are not regulated under the FHACA Rules, as discussed in Section 2.1.1. However, if the riparian zone extends beyond the limit of the coastal wetlands, the riparian zone standards are applied to that portion outside of the coastal wetlands. See Figure 6.18, on the following page.

Figure 6.18: The Riparian Zone of a Regulated Water Flowing Through Coastal Wetlands



6.4 Requirements for a Regulated Activity in the Riparian Zone

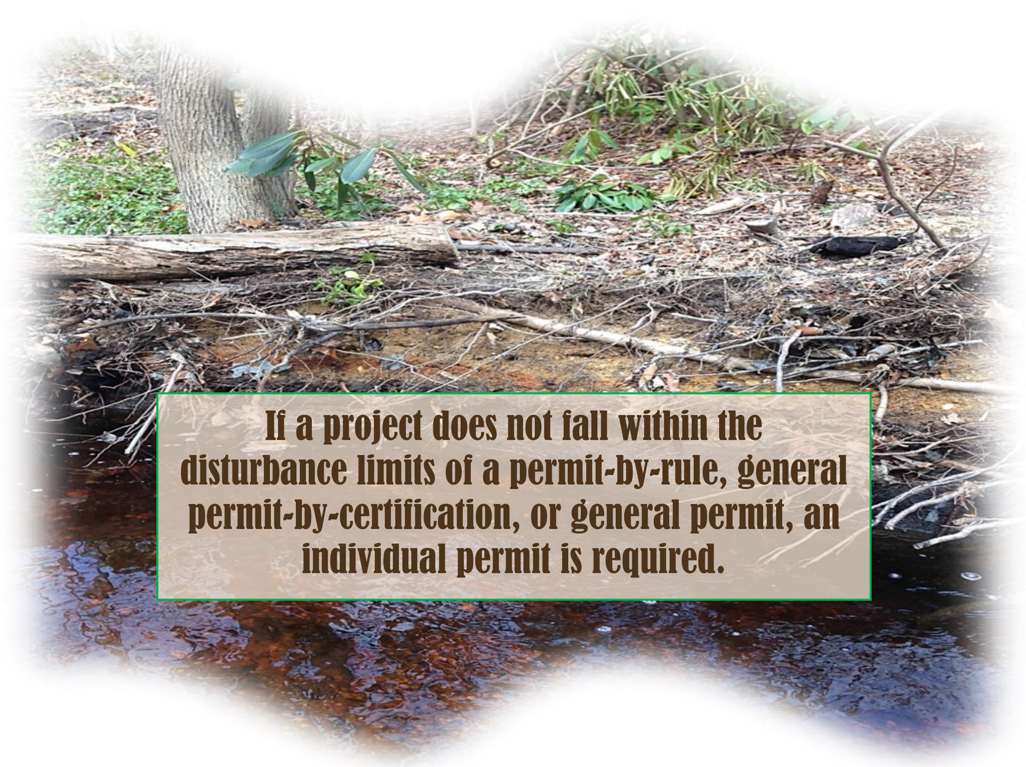
The riparian zone is a distinct regulated area, and as such, any activity located within it is subject to the jurisdiction of the FHACA Rules (see N.J.A.C. 7:13-2.4). The purpose of regulating the riparian zone, as previously mentioned, is to preserve vegetation of any kind because of the many benefits that vegetation in this area provides.

The FHACA Rules do not provide differentiated protection for one type of vegetation over another. All vegetation in the riparian zone is protected, and any clearing, cutting, or removing of riparian zone vegetation is regulated. This applies equally to trees, grass, meadows, brush, lawns, gardens, and agricultural fields (active or otherwise, even if the area has been plowed under) as well as any areas from which vegetation has been unlawfully cleared, cut, or removed.

While all riparian zone vegetation is of value, the FHACA Rules recognize that riparian zone disturbance is sometimes unavoidable, and in such cases, it should take place in areas that are considered actively disturbed. The FHACA Rules define an *actively disturbed area* as "any expanse of land within a riparian zone in which vegetation has been permanently or periodically cleared, cut, removed, or otherwise altered by humans to accommodate an ongoing, lawfully existing land use." See N.J.A.C. 7:13-1.2 for some examples of actively disturbed areas.

Various permits-by-rule, general permits-by-certification, and general permits have been adopted to recognize that certain regulated activities warrant minor disturbance to riparian zone vegetation and to encourage these activities to be undertaken in portions of the riparian zone that are considered actively disturbed. For example, the permit-by-rule at N.J.A.C. 7:13-7.21 allows the construction of a residential swimming pool in certain cases, provided that "Any clearing, cutting, and/or removal of riparian zone vegetation is limited to actively disturbed areas."

Some permits-by-rule, general permits-by-certification, and general permits include limitations on the amount of riparian zone disturbance that can occur to qualify for authorization. These limitations are cited in the FHACA Rules and directly in the text of the specific general permit-by-certification or general permit. If a project does not fall within the disturbance limits of a permit-by-rule, general permit-by-certification, or general permit, an individual permit is required. See Section 3.1 of this manual for more information on the various types of permits and authorizations available under the FHACA Rules.



N.J.A.C. 7:13-11.2 contains the requirements that must be met for the issuance of an individual permit for any regulated activity located in a riparian zone as well as activity-specific riparian zone requirements that must be met for a given activity in addition to any other requirements applicable to an individual permit for that activity. The rules also include a number of specific limits and requirements for acceptable uses in the riparian zone.

For a proposed activity that results in the clearing, cutting, or removal of vegetation in a riparian zone to be approved under an individual permit, it must satisfy the following three requirements:

1. It must meet all general conditions for riparian zone disturbance located at:

- → N.J.A.C. 7:13-11.2(b), explained in Section 6.4.1
- → N.J.A.C. 7:13-11.2(c), explained in Section 6.4.4
- → N.J.A.C. 7:13-11.2(d), explained in Section 6.4.5
- → N.J.A.C. 7:13-11.2(z)

2. It cannot exceed the limitations on the area of disturbance under Table 11.2 (see Section 6.4.2) unless specifically provided for in N.J.A.C. 7:13-11.2(g) through (y).

- → It should be noted that some regulated activities, listed at N.J.A.C. 7:13-11.2(f) and explained in Section 6.4.3, are not subject to the limits in Table 11.2 and are not to be included when calculating the total area of vegetation to be cleared, cut, and/or removed under the table.

3. It must meet any activity-specific conditions that may apply under N.J.A.C. 7:13-11.2(g) through (y).

6.4.1 General Conditions at N.J.A.C. 7:13-11.2(b)

N.J.A.C. 7:13-11.2(b) contains the standards that must be considered prior to proposing disturbance to any riparian zone vegetation. These standards require the applicant to demonstrate that disturbance to the riparian zone is necessary and, where it is deemed necessary, that the disturbance is minimized. The six requirements under this subsection must all be met for the Department to permit a regulated activity within a riparian zone.

1. **<u>N.J.A.C. 7:13-11.2(b)1</u>**

   N.J.A.C. 7:13-11.2(b)1 requires that it must first be determined that the basic purpose of the project cannot be accomplished onsite without disturbing riparian zone vegetation for the Department to allow a regulated activity to be conducted within a riparian zone. The intent of this provision is to prevent unnecessary disturbance to such vegetation.

If a regulated activity can be conducted outside a riparian zone and still serve its intended purpose and function, the activity must be conducted outside the riparian zone. Some projects cannot serve their basic purpose or function outside the riparian zone. For example, a roadway constructed across a stream to reach an otherwise inaccessible piece of land on the other side must necessarily cross through the riparian zone. The area of disturbance can be minimized by carefully configuring the roadway's location or width, but the basic purpose of the project cannot be accomplished without loss of riparian zone vegetation.

Some activities are water-dependent and therefore must access the edge of water or the channel. A boat ramp, fishing pier, or public access to the water, for example, could not possibly be constructed outside a riparian zone. Conversely, the basic purpose of a house is to provide habitation for humans, a function served equally well within or outside a riparian zone. On a vacant lot, there may be several potential locations to construct a new house. If on a given site there exists a viable location outside a riparian zone where a house can be built, N.J.A.C. 7:13-11.2(b)1 prevents the construction of a new house within the riparian zone on that site. However, if all or a large portion of a site lies within a riparian zone such that any house constructed on that site would necessarily impact the riparian zone, N.J.A.C. 7:13-11.2(m) permits the construction of the house within the riparian zone since there is no alternative location onsite that would avoid disturbing the riparian zone.

2. N.J.A.C. 7:13-11.2(b)2

If disturbance to the riparian zone is deemed necessary, N.J.A.C. 7:13-11.2(b)2 requires that the disturbance must be minimized for the Department to allow the regulated activity to be conducted. To determine whether this criterion is satisfied, the Department will examine various alternatives, including situating the regulated activity or project as far from any regulated water as feasible and/or limiting construction to actively disturbed areas or to portions of the riparian zone where previous development has occurred. This includes areas devoid of vegetation, such as:

- **Areas covered with structures or other impervious surface**
- **Abandoned pavement that has partially revegetated**
- **Areas of dirt and gravel that are primarily devoid of vegetation**
- **Eroded embankments**
- **Landscape islands within paved parking areas**

The Department will evaluate each project to determine whether another reasonable location on site or another configuration is available that would minimize or eliminate disturbance to the riparian zone.

3. **N.J.A.C. 7:13-11.2(b)3**

N.J.A.C. 7:13-11.2(b)3 requires all existing onsite impervious surface within 25 feet of the top of bank to be removed and the riparian zone to be replanted with native, non-invasive vegetation. This requirement is discussed in more detail in Section 6.4.7 of this manual.

4. **N.J.A.C. 7:13-11.2(b)4**

N.J.A.C. 7:13-11.2(b)4 stipulates that all requirements for each specific regulated activity, as described at N.J.A.C. 7:13-11.2(g) through (y), including any requirements for mitigation (see N.J.A.C. 7:13-13 and Section 7 of this manual), must be met.

5. **N.J.A.C. 7:13-11.2(b)5**

N.J.A.C. 7:13-11.2(b)5 provides that the Department will allow a regulated activity to be conducted within a riparian zone only if all temporarily disturbed areas in the riparian zone are replanted with native, non-invasive vegetation upon completion of the project. The acceptable method for replanting is discussed in N.J.A.C. 7:13-11.2(z). The Department recognizes that some disturbance within the riparian zone is of a temporary nature and therefore establishes the requirement to restore such disturbed areas. Section 6.4.6 of this manual discusses temporary and permanent riparian zone disturbances.

6. **N.J.A.C. 7:13-11.2(b)6**

N.J.A.C. 7:13-11.2(b)6 explains that a given project proposed within a riparian zone may be subject to additional requirements and limitations that are found elsewhere in the FHACA Rules. For example, while both Table 11.2 (see Section 6.4.2, below) and N.J.A.C. 7:13-11.2(v) provide the basic parameters and upper limits on disturbance to vegetation in the riparian zone for flood control projects, N.J.A.C. 7:13-12.12 includes additional requirements that must be considered specifically for such projects. Therefore, it should not be assumed that the full amount of disturbance allowed under this section is always warranted or will be allowed for a given project. Table 11.2 merely establishes the basic parameters and upper limits on disturbance to vegetation in the riparian zone that the Department believes could reasonably be required to accomplish the various activities listed in the table. It should be remembered that the values contained in Table 11.2 represent the maximum allowable disturbance for a given activity, unless specifically provided for in N.J.A.C. 7:13-11.2(g) through (y), and that all disturbances must first be justified and minimized under N.J.A.C. 7:13-11.2(b).

6.4.2 Table 11.2

Table 11.2 (reprinted on pages 151-153) establishes the maximum allowable area of riparian zone vegetation that can be temporarily or permanently cleared, cut, and/or removed. Riparian zone disturbance for a given regulated activity includes:

The area of any riparian zone vegetation within the project's limit of disturbance shown on the site plans submitted by the applicant → The area under the canopy of any trees to be cleared, cut, or removed within the riparian zone → All other areas in the riparian zone from which vegetation is to be temporarily or permanently cleared, cut, and/or removed to conduct the regulated activity

The amount of vegetation *cut* refers to physical removal of vegetation and does not refer to trimming of trees and shrubs that would meet the requirements of permit-by-rule 1 for normal property maintenance (see N.J.A.C. 7:13-7.1).

Disturbance to trees is measured by aerial coverage and not by the number of trees impacted. The area of impact must be used when calculating the total disturbance to forested areas. Usually, the limit of disturbance or proposed tree line shown on submitted plans is a fairly accurate representation of the total disturbance to forested areas. However, in some cases where vegetation is removed or converted in the understory without removing trees, the disturbance would encroach within the proposed tree line. In these cases, the disturbance to the understory is still counted as removal of riparian zone vegetation even though the canopy of the trees above it remains intact.

The categories in Table 11.2 are meant to capture activities that are most likely to occur in proximity to streams, such as water dependent projects, stream stabilization projects, and flood control projects. In addition, Table 11.2 includes activities for which riparian zone disturbance is unavoidable, such as infrastructure projects. Lastly, activities are represented to allow property owners to utilize their properties, such as construction of one single-family dwelling or duplex.

A person may undertake more than one regulated activity on a single site, but the requirements for each separate regulated activity must be met. Except for the construction of an addition to an existing single-family home or duplex or the construction of an accessory structure under N.J.A.C. 7:13-11.2(n), the limits in Table 11.2 apply to each individual occurrence of a proposed regulated activity on a site or as part of a project. For example, a person can obtain an individual permit for multiple stormwater outfall structures on a single site, provided the limits in Table 11.2 (and all other requirements) are met for each individual outfall structure.

If a project is not specifically listed in Table 11.2, the project must meet the limits and requirements of N.J.A.C. 7:13-11.2(y). For instance, Table 11.2 includes a category for a single-family dwelling or duplex. This category is intended for one dwelling on a single property. If an applicant were to propose multiple single-family dwellings on a property, N.J.A.C. 7:13(m) could not be utilized for the disturbance. The project would need to meet the requirements of N.J.A.C. 7:13-11.2(y). N.J.A.C. 7:13-11.2(y)2 requires the applicant to avoid or minimize impacts to the riparian zone where the clearing, cutting, and/or removal of riparian zone vegetation is located within an actively disturbed area.

However, where riparian zone vegetation is cleared, cut, and/or removed outside of an actively disturbed area, N.J.A.C.7:13-11.2(y)3 requires the applicant to demonstrate that there is no other feasible use of the site that would reduce or eliminate the area of riparian zone vegetation to be disturbed, such as constructing a different type of project onsite, reducing the size or scope of the project, or relocating the project to a different portion of the site. If the applicant cannot meet this requirement, multiple single-family dwellings would not be permitted on the property. Furthermore, if feasible alternatives exist, it is unlikely the requirements for a hardship exception, as described at N.J.A.C. 7:13-15.1 et seq, would be satisfied.

If an activity is listed in Table 11.2 but the proposed project cannot meet one of the project-specific conditions located in N.J.A.C. 7:13-11.2, a hardship exception is required. An applicant cannot propose that activity under N.J.A.C. 11.2(y). For example, N.J.A.C. 7:13-11.2(m) allows riparian zone disturbance for construction of a single-family dwelling or duplex on a lot that was created or subdivided after November 5, 2007 if the applicant demonstrates that none of the lots created in the subdivision contain a habitable building or possess a valid authorization from the Department to construct a habitable building in the riparian zone. If a site was subdivided after November 5, 2007 or has not yet been subdivided but already contains a habitable building, the project cannot be authorized under N.J.A.C. 11.2(m) or N.J.A.C. 11.2(y) and must instead meet the standards of a hardship exception.

Table 11.2

MAXIMUM ALLOWABLE AREA OF RIPARIAN ZONE VEGETATION THAT CAN BE TEMPORARILY OR PERMANENTLY CLEARED, CUT, AND/OR REMOVED WITHOUT ADDITIONAL JUSTIFICATION AND/OR A HARDSHIP EXCEPTION REQUEST, IN ACCORDANCE WITH (e) ABOVE

Proposed Regulated Activity		**See Subsection Below for Additional Requirements**	**Allowable Disturbance Based on the Width of the Riparian Zone**		
			50-foot Riparian Zone	**150-foot Riparian Zone**	**300-foot Riparian Zone**
• **Railroad or public roadway**					
New	Crossing a water	(g)	6,000 ft^2	18,000 ft^2	36,000 ft^2
	Not crossing a water		3,000 ft^2	9,000 ft^2	18,000 ft^2
Reconstructed	Crossing a water		3,000 ft^2	9,000 ft^2	18,000 ft^2
	Not crossing a water		1,500 ft^2	4,500 ft^2	9,000 ft^2
• **Private driveway serving one single-family home or duplex**					
New	Crossing a water	(h)	2,000 ft^2	6,000 ft^2	12,000 ft^2
	Not crossing a water		1,000 ft^2	3,000 ft^2	6,000 ft^2
Reconstructed	Crossing a water		1,000 ft^2	3,000 ft^2	6,000 ft^2
	Not crossing a water		500 ft^2	1,500 ft^2	3,000 ft^2

• **All other roadways not listed above**					
New	Crossing a water	(h)	4,000 ft^2	12,000 ft^2	24,000 ft^2
	Not crossing a water		2,000 ft^2	6,000 ft^2	12,000 ft^2
Reconstructed	Crossing a water		2,000 ft^2	6,000 ft^2	12,000 ft^2
	Not crossing a water		1,000 ft^2	3,000 ft^2	6,000 ft^2
• **Bank stabilization and channel restoration**					
Areas stabilized with vegetation and/or soil bioengineering		(i)	No limit if disturbance is justified		
Areas stabilized using other methods			10 ft^2 per linear foot of armoring		
Access to the project			1,000 ft^2	3,000 ft^2	6,000 ft^2
• **Stormwater discharge**					
Headwall and outlet protection		(j)	2,000 ft^2	2,000 ft^2	2,000 ft^2
Stormwater pipe			1,000 ft^2	3,000 ft^2	6,000 ft^2
• **Utility line**					
New		(k)	30 ft^2 per linear foot of utility line		
Access to the project (per crossing)			1,000 ft^2	3,000 ft^2	6,000 ft^2
Reconstruction, upgrade, expansion, or maintenance		(l)	No limit if disturbance is justified		
Access to the project (per crossing)			1,000 ft^2	3,000 ft^2	6,000 ft^2
• **Single-family home or duplex**					
New		(m)	3,500 ft^2	7,000 ft^2	7,000 ft^2
Reconstruction			2,000 ft^2	2,000 ft^2	2,000 ft^2
Addition		(n)	2,000 ft^2 for all additions, cumulatively since November 5, 2007		
Accessory structure			4,000 ft^2 for all accessory structures, cumulatively since November 5, 2007		
• **Tidal development**					
Public access		(o)	No limit if disturbance is justified		
Water dependent development		(p)	No limit if disturbance is justified		
• **Other projects**					
Individual subsurface sewage disposal system		(q)	5,000 ft^2	5,000 ft^2	5,000 ft^2
Hazardous substance remediation		(r)	No limit if disturbance is justified		
Solid waste facility closure		(s)	No limit if disturbance is justified		
Trail or boardwalk		(t)	10 ft^2 per linear foot of trail or boardwalk, not to exceed one acre		
Footbridge		(u)	1,000 ft^2	1,000 ft^2	1,000 ft^2
Flood control project		(v)	3,000 ft^2	9,000 ft^2	18,000 ft^2
Removing sediment and/or debris from a regulated water		(w)	1,000 ft^2 per access point		

Removing existing fill and/or an existing structure	(x)	Within 20 feet of the fill or structure, not to exceed one acre		
Any regulated activity not listed in this table above				
Total area of disturbance permitted	(y)	One-quarter of an acre		6,000 ft^2
Maximum portion of the total area of disturbance permitted above, which can be located within a riparian zone that is not an actively disturbed area		1.000 ft^2	3,000 ft^2	3,000 ft^2 (must be located more than 150 feet from the top of bank.)

6.4.3 Exceptions to Table 11.2

Certain regulated activities are not subject to the limits in Table 11.2 (reprinted on pages 151-153, above) and do not need to be included when calculating riparian zone disturbance. These include activities that will not disturb any vegetation, such as construction on lawfully existing impervious surface, and activities that disturb vegetation that is completely submerged during normal flow conditions in a regulated water. Converting riparian zone vegetation within an actively disturbed area (see the definition and examples at N.J.A.C. 7:13-1.2) from one type to another is also exempt from the table, provided there is no net loss in the area of vegetation. For example, converting an actively farmed area into a lawn would be exempt from the limits in Table 11.2.

Temporary disturbances within an actively disturbed area and relocating a lawfully existing structure to an actively disturbed area on the same site, provided the area formerly occupied by the structure is stabilized and replanted, are also exempt and are discussed further in Section 6.4.6 of this manual.

A regulated activity along a lawfully existing public roadway does not need to be considered when calculating riparian zone disturbance, provided all of the following apply:

- ✓ It is located within an actively disturbed area and within an existing right-of-way or easement.
- ✓ It is situated on a lawfully existing roadway embankment or within an area adjacent to a lawfully existing roadway that was disturbed for the initial construction of the roadway.
- ✓ It is undertaken by a public entity.
- ✓ It is necessary for the continued, safe use of the roadway.
- ✓ It does not disturb more than one acre of riparian zone vegetation.

Finally, any disturbance to vegetation within a truncated portion of a riparian zone does not need to be counted towards the limits in Table 11.2. A riparian zone is considered truncated if the area is separated from a regulated water by a lawfully existing railroad or public roadway, the area does not slope toward the regulated water, and stormwater runoff from the area does not drain into the regulated water (see Figure 6.19, below). When determining whether an area slopes toward a regulated water, the Department will take into consideration any site-specific topographical information available to the Department. However, the presence of existing or proposed structures and drainage systems or proposed grading or other manmade topographic alterations do not affect whether an area slopes toward a regulated water.

Figure 6.19: A Truncated Portion of a Riparian Zone

6.4.4 Work Within 25 Feet of Top of Bank

As the top of bank of a waterbody is approached, vegetation becomes even more vital in promoting bank stability, attenuating storm flows, ensuring food for aquatic organisms, and providing shade to the waterbody, which is necessary to maintain water temperature and healthy levels of dissolved oxygen for aquatic life. Therefore, in cases where riparian zone disturbance is justified, the Department has determined that 25 feet is the absolute minimum width for any vegetated riparian zones to ensure these ecological functions are maintained. For Category One waters, which have such exceptional ecological, recreational, water supply, and/or fisheries significance that they are afforded a 300-foot riparian zone, 150 feet is the minimum width necessary to protect these critical waters (see Section 6.4.5).

This important top of bank principle is reflected throughout the FHACA Rules (see Section 6.2 for information on how to determine top of bank). For example, many permits-by-rule, general permits-by-certification, and general permits prohibit the disturbance of vegetation within 25, 75, or 150 feet of top of bank. Additionally, redevelopment projects (with limited exceptions) are required under the individual permit requirements for a regulated activity in a riparian zone at N.J.A.C. 7:13-11.2(b) to remove any impervious surfaces that may exist within 25 feet of top of bank and to revegetate these areas, as explained in Section 6.4.7 of this manual. The individual permit requirements at N.J.A.C. 7:13-11.2(c) also prohibit the clearing, cutting, or removal of vegetation within 25 feet of the top of bank in riparian zones.

Although undesirable, the Department recognizes that there are cases where disturbances within 25 feet of the top of bank may be justified and unavoidable, such as for the construction of a roadway, railway, outfall, or utility line that crosses a water. In these cases, per N.J.A.C. 7:13-11.2(b), applicants must first demonstrate that the purpose of the project cannot be accomplished without disturbances to vegetation within a riparian zone, specifically vegetation within 25 feet of the top of bank (see Section 6.4.1 above).

In most cases, the Department will not approve the construction of any activity that will permanently remove vegetation within 25 feet of the top of bank in a riparian zone unless the structure is necessary for sediment removal activities or for riparian zone, freshwater wetlands, and/or habitat restoration or if the structure must cross or requires proximity to a water, such as a stormwater discharge, a bank stabilization project, a public trail or boardwalk, or an improvement to existing infrastructure that is necessary to maintain public safety. Activities that are not water-dependent, such as constructing parking lots, homes, and other buildings, or the removal of vegetation to store vehicles and equipment are not considered justifiable disturbances to this critical area. The only exceptions are regulated activities located within an actively disturbed area that is adjacent to a lawfully existing bulkhead, retaining wall, or revetment along a tidal water or impounded fluvial water.

6.4.5 Work Within 150 Feet of Top of Bank in a 300-Foot Riparian Zone

As previously mentioned in Section 6.1.1 above, Category One waters and their tributaries contain the most critical resources and therefore possess a 300-foot riparian zone. Because vegetation becomes more essential for protecting the critical resources of a water as the top of bank is approached, N.J.A.C. 7:13-11.2(d) prohibits the clearing, cutting, and/or removal of vegetation within 150 feet of the top of bank within a 300-foot riparian zone unless **all** of the following apply:

1. There is no practicable alternative to the regulated activity that would have less adverse impacts on regulated areas and which would not significantly compromise other environmental resources.

2. The regulated activity results in the minimum feasible alteration or impairment of the riparian zone or aquatic ecosystem.

3. The regulated activity is in the public interest.

The factors that the Department will consider in determining public interest include all of the following:

1. The public interest in preservation of natural resources and the interest of the property owners in reasonable economic development

2. The extent of the public and private need for the proposed regulated activity

3. The practicability of using reasonable alternative locations and methods to accomplish the purpose of the proposed regulated activity

4. The extent and permanence of the beneficial or detrimental effects that the proposed regulated activity may have on the public and private uses for which the property is suited

5. The functions and values provided by the riparian zone proposed to be impacted

6. The probable individual and cumulative impacts of the regulated activity on public health, safety, and welfare and the environment

The purpose of the public interest requirement is to ensure that applicants proposing regulated activities within 150 feet of the top of bank in a 300-foot riparian zone evaluate all potential benefits or adverse impacts that may occur. This list of factors is intended to guide prospective applicants regarding the type of information the Department is interested in evaluating as part of the review of individual permit applications for projects within 150 feet of the top of bank in a 300-foot riparian zone. The Department does not provide a list of objective criteria for each of these factors because each site and/or project may have a diverse array of beneficial effects and adverse impacts, so such a list could never be exhaustive. The Department will instead evaluate each project on a case-by-case basis with regard to public interest.

6.4.6 Temporary and Permanent Disturbance in the Riparian Zone

In many cases, certain types of vegetation (such as forested areas) cannot be easily restored to their original condition after temporary disturbance has occurred. For this reason, the FHACA Rules at N.J.A.C. 7:13-11.2(e) require that all temporary and permanent disturbances to riparian zone vegetation (except for those activities listed at N.J.A.C. 7:13-11.2(f) and explained in Section 6.4.3 above) must be applied toward the maximum limits of disturbance under Table 11.2 (see Section 6.4.2).

Permanent disturbance to the riparian zone occurs when the vegetation is replaced with an impervious surface or structure or when vegetation is converted from a higher ecological value to a lower one (i.e. trees to herbaceous vegetation).

Temporary disturbance within the riparian zone consists of the removal or alteration of vegetation for an activity lasting no longer than six months, provided that the original vegetative cover onsite is restored to the previous (or an improved) condition. Examples of temporary disturbances include construction access routes and staging areas. In some cases, a project such as a remediation project or landfill closure will exceed the six-month time frame required for temporary disturbances. Since these projects, by their nature, have a longer construction time frame, they will be considered temporary, provided the area is restored to its previous condition or to an improved condition.

Some activities may require access through forested or scrub/shrub riparian zones, such as stream stabilization projects (see Section 12.5 of this manual) and flood control projects. The removal of woody vegetation for construction access would be considered a temporary disturbance. However, once the activity is complete, the access route must be planted with trees and shrubs according to the requirements at N.J.A.C. 7:13-11.2(z). Likewise, construction projects that require access through forested or scrub/shrub riparian zones must be replanted with trees and shrubs following construction. When planning construction access and staging areas, existing road and trails or actively disturbed and herbaceous portions of the riparian zone should be utilized where possible.

In some cases, an actively disturbed area, such as a maintained lawn or garden, may need to be temporarily disturbed to accommodate a nearby construction activity and/or to facilitate the construction or repair of something below ground. In other cases, a lawfully existing structure may need to be permanently relocated to an actively disturbed area on the same site, but the area formerly occupied by the structure will be stabilized and replanted with vegetation. Examples of these types of disturbances include:

- The construction or repair of a septic system
- The remediation of contaminated soil
- The placement of an underground utility line
- The relocation or improvement of trails, footbridges, and other features within a park or golf course

Where an actively disturbed area will be temporarily disturbed to accommodate a proposed construction activity, the disturbed area can be quickly and easily restored to its original condition, and no adverse environmental impact will occur. Similarly, when a lawfully existing structure will be relocated to an actively disturbed area and the area formerly occupied by that structure will be replanted with vegetation, the disturbance can be quickly and easily compensated for without any adverse environmental impact.

As previously mentioned in Section 6.4.3, temporary disturbance to actively disturbed areas within riparian zones do not count toward the maximum allowable limits in Table 11.2, provided the disturbed area is replanted immediately after the completion of the activity unless prevented by seasonal weather. In that case, replanting must occur as soon as conditions allow. Likewise, permanent disturbances to actively disturbed areas resulting from the relocation of lawfully existing structures where the area formerly occupied by the structure will be replanted with vegetation do not count toward the limits in the table.

However, in some cases, an area of maintained lawn or garden may be permanently disturbed to accommodate a new activity, but an equal or greater area of lawn or garden will be created within the riparian zone along the same stream to compensate. In these cases, the total net disturbance to such areas will count toward the maximum allowable limits in Table 11.2.

EXAMPLES:

EXAMPLE 1

A person intends to repair a failing septic system, which will result in 3,000 square feet of temporary riparian zone disturbance. Of this area, 2,000 square feet is a maintained lawn, and 1,000 square feet is forested. Upon completion of the project, the entire 3,000 square feet will become lawn. In such a case, the 2,000 square feet of disturbed lawn can be ignored since it will be fully restored upon completion of the project. The 1,000 square feet of disturbed forest, however, must comply with the requirements of N.J.A.C. 7:13-11.2(q).

EXAMPLE 2

The owners of a golf course intend to relocate an existing walkway and footbridge to an area that is currently a maintained lawn along the same stream onsite. The area currently occupied by the walkway and footbridge will be converted to a lawn, and there will be no net loss of lawn area. In such a case, the disturbed lawn area can be ignored since it will be fully compensated for by the creation of new lawn where the walkway and footbridge currently exist. However, should there be a net loss of lawn area, any such loss must comply with the requirements of N.J.A.C. 7:13-11.2(t) and (u) and any loss above the limits provided in these sections will require mitigation as described at N.J.A.C. 7:13-7:13 and in Section 7.1 of this manual.

6.4.7 Redevelopment in the Riparian Zone

N.J.A.C. 7:13-11.2(b)3 provides requirements for certain redevelopment activities within the riparian zone. In older developments, structures and other impervious surfaces are commonly situated very close to the top of bank, and in some cases, pavement can extend up to the top of bank itself. Such development causes increased erosion within the channel, degrades water quality, and poses a public safety risk since such structures can become undermined and sustain structural damage and/or collapse as the size and shape of the channel changes over time.

To prevent the continuation of such conditions, in cases where an applicant proposes to redevelop a site, all existing impervious surface within 25 feet of the top of bank must be removed and the riparian zone must be replanted with vegetation as described at N.J.A.C. 7:13-11.2(z) regardless of whether the proposed activity itself will be located within 25 feet of top of bank.

The following exceptions apply:

~ Activities located within actively disturbed areas adjacent to lawfully existing bulkheads, retaining walls, or revetments along tidal waters or impounded fluvial waters

~ Cases where an applicant demonstrates that removing and/or preventing the replacement of the existing impervious surface within 25 feet of the top of bank would likely exacerbate flooding or erosion, expose hazardous substances or solid waste, or otherwise threaten public health, safety, welfare, and /or the environment (provided that all other portions of the riparian zone within 25 feet of the top of bank are replanted with vegetation as required at N.J.A.C. 7:13-11.2(z) to the extent feasible and protective of public health, safety, and welfare and the environment.

- Instances where an applicant demonstrates that removing and/or preventing replacement of the existing impervious surface within 25 feet of top of bank would prevent reasonable use or access to the site and/or cause an unreasonable burden on the applicant

6.5 Buffers and Transition Areas Under Other Regulations

The FHACA Rules at N.J.A.C. 7:13-4.1(i) clarify that in addition to the riparian zones in this rule, other Department rules also protect near-stream areas. Projects subject to other rules must meet any applicable buffer requirements as well as the riparian zone requirements under this rule. For example, the Highlands Water Protection and Planning Act Rules at N.J.A.C. 7:38 establish 300-foot buffers adjacent to certain waters under certain circumstances. The Freshwater Wetlands Protection Act Rules at N.J.A.C. 7:7A establish 50-foot and 150-foot transition areas along certain freshwater wetlands and other features that may also be regulated under the FHACA Rules. Additionally, transition areas of up to 300 feet lie adjacent to freshwater wetlands in the Pinelands Region under the Pinelands Comprehensive Management Plan at N.J.A.C. 7:50-6.14. Accordingly, the FHACA Rules make it clear that projects must comply with any applicable similar buffer requirements that may be imposed at the Federal, State and/or local levels.

SECTION 7 MITIGATION

As discussed in Section 6 of this manual, riparian zone vegetation is critical for maintaining water quality and temperature, stabilizing banks, providing protection from flooding, and serving as wildlife habitat. For these reasons, when a regulated activity authorized under an individual permit disturbs riparian zone vegetation, compensation (commonly referred to as mitigation) is often required.

All mitigation projects must fully compensate for any ecological loss associated with the regulated activity. To accomplish this, the FHACA Rules contain requirements for riparian zone mitigation at N.J.A.C. 7:13-13, including standards for:

- When mitigation is required — See Section 7.1
- Where mitigation may be performed — See Section 7.2
- How mitigation can be accomplished — See Section 7.3
- When mitigation projects must commence — See Section 7.4
- The monitoring of mitigation projects — See Section 7.5
- The submission of financial assurance to guarantee that mitigation will be completed as required — See Section 7.6

This manual does not address mitigation for freshwater wetlands, state open waters, or coastal wetlands.

7.1 When Mitigation is Required

To determine if mitigation is required for a proposed activity, an applicant should refer to N.J.A.C. 7:13-11.2(e). Generally, mitigation is required if the activity meets one or more of the following:

The activity is a hazardous substance remediation - see N.J.A.C. 7:13-11.2(r).

The activity is a solid wastes facility closure - see N.J.A.C. 7:13-11.2(s).

The activity is not listed in Table 11.2 - see N.J.A.C. 7:13-11.2(y).

The total amount of riparian zone vegetation to be cleared, cut, and/or removed exceeds the limits in Table 11.2.

The regulated activity is located within a 300-foot riparian zone.

N.J.A.C. 7:13-13.4(b) provides the standards for when mitigation is required in a 300-foot riparian zone (see Section 6.1 for information on how to determine the width of the riparian zone). For most regulated activities located within a 300-foot riparian zone, mitigation is required for the total area of vegetation that is disturbed. However, this requirement does not apply to the following activities **unless** the limits in Table 11.2 are exceeded:

- The construction of a new aboveground or underground utility line that meets the requirements of N.J.A.C. 7:13-11.2(k)
- The reconstruction, replacement, repair, or maintenance of an existing aboveground or underground utility line that meets the requirements of N.J.A.C. 7:13-11.2(l)
- Construction associated with a single-family home or duplex that meets the requirements of N.J.A.C. 7:13-11.2(m) or (n)
- The construction of a trail or boardwalk that meets the requirements of N.J.A.C. 7:13-11.2(t)

Some examples of when mitigation is required are provided on the following page.

N.J.A.C. 7:13-13.4(c) provides the standards for when mitigation is required in a 50-foot or a 150-foot riparian zone. If a regulated activity is located within a 50-foot or a 150-foot riparian zone, mitigation is required as follows:

For the investigation, cleanup, or removal of hazardous substances under N.J.A.C. 7:13- 11.2(r)	Mitigation is required for the total area of vegetation that is cleared, cut, and/or removed.
For a solid waste landfill closure and post-closure plan or disruption approval under N.J.A.C. 7:13-11.2(s)	Mitigation is required for the total area of vegetation that is cleared, cut, and/or removed.
For a regulated activity subject to N.J.A.C. 7:13-11.2(y)	Mitigation is required for the total area of vegetation that is cleared, cut, and/or removed if the activity results in the disturbance of more than 2,000 square feet of riparian zone vegetation.
For all other regulated activities	Mitigation is required for the area of any riparian zone vegetation that is disturbed in excess of the limit in Table 11.2.

EXAMPLES OF WHEN MITIGATION IS REQUIRED:

Example 1: For a regulated activity not listed in Table 11.2 where 3,000 square feet of riparian zone vegetation are disturbed in a 50, 150, or 300-foot riparian zone, mitigation is required for all 3,000 square feet.

Example 2: For a regulated activity associated with a solid waste facility closure where 1,000 square feet of riparian zone vegetation are disturbed in a 50, 150, or 300-foot riparian zone, mitigation is required for all 1,000 square feet.

Example 3: For a new roadway crossing a water within a 300-foot riparian zone, Table 11.2 allows for 36,000 square feet of disturbance. The permit approved 30,000 square feet of disturbance. Mitigation will be required for all 30,000 square feet of disturbance because the disturbance is to the riparian zone of a waterway with a 300-foot riparian zone.

Example 4: For the construction of a new, 500-foot utility line where 30 square feet of riparian zone vegetation are disturbed per linear foot, no mitigation is required in a 300-foot riparian zone. However, if the activity results in the clearing of 31 square feet per linear foot of utility line within a 300-foot riparian zone, mitigation is required for all 15,500 square feet of disturbance (31 square feet per linear foot x 500 linear feet = 15,500 square feet).

If a regulated activity includes both permanent and temporary disturbances, the applicant should review Section 6.4.3 of this manual to determine the types of activities that are not subject to Table 11.2. These activities may be subject to N.J.A.C. 7:13-11.2(z), which requires that all riparian zone vegetation that is disturbed for the purposes of conducting a regulated activity, accessing an area where regulated activities will be conducted, or otherwise accommodating a regulated activity be replanted immediately after completion of the regulated activity.

For example, for the construction of a new single-family home within a 300-foot riparian zone, Table 11.2 allows for 7,000 square feet of riparian zone disturbance. As part of the construction, the applicant is proposing to disturb 2,000 square feet of lawn that will be replanted immediately after construction. The restoration of the lawn does not count towards the limits in Table 11.2. However, in addition to the 2,000 square feet of temporary disturbance to the lawn, 6,000 square feet of herbaceous vegetation will be permanently disturbed to accommodate the proposed dwelling. Because N.J.A.C. 7:13-13.4(b)3 provides that mitigation is only required for construction associated with a single-family home or duplex in a 300-foot riparian zone if the disturbance amount exceeds that which is allowed in Table 11.2, mitigation would not be required for the 6,000 square feet of disturbance. However, if the construction of the house were to result in 2,000 square feet of temporary disturbance to the lawn and 8,000 square feet of permanent disturbance to accommodate the dwelling, mitigation would be required for all 8,000 square feet of the permanent disturbance for exceeding the limit in Table 11.2.

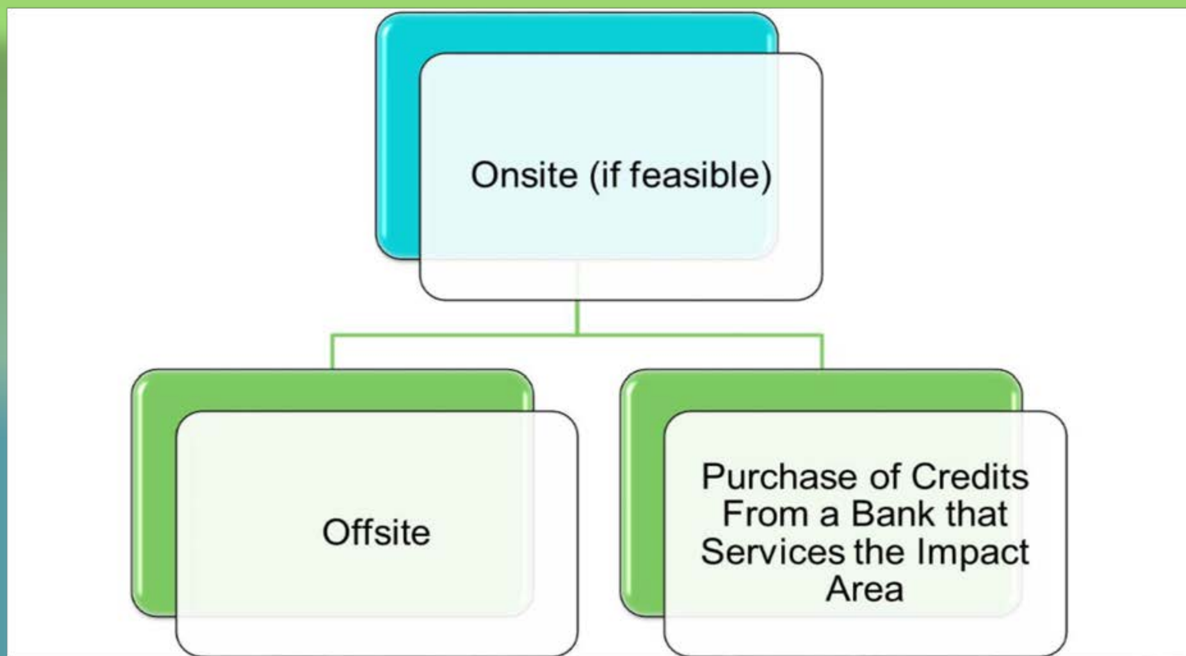
7.2 Where to Perform Mitigation

Mitigation may be carried out on either private or public property. However, in both cases, the property must be owned in fee simple and under the legal control of the person who is performing the mitigation unless that person demonstrates that they have sufficient legal rights to the property to comply with the FHACA Rules. Any portion of the property with an existing easement or other encumbrance will be excluded when the mitigation project area is calculated. The owner of the property must also be willing to permanently protect the mitigation project area from future development through a conservation restriction. For mitigation on public property, the public entity must either agree to record the conservation restriction on the mitigation project area or demonstrate that an existing conservation restriction will protect that area in perpetuity.

If a public property was purchased with Green Acres funding or is subject to any Green Acres restrictions, the Green Acres Program must approve the use of that property for mitigation.

The mitigation area must be the same type of ecosystem as the disturbed area. In addition, the location of any proposed mitigation site must meet the requirements of the FHACA Rules at N.J.A.C. 7:13-13.9, which provides a riparian zone hierarchy (illustrated in Figure 7.1 on the next page) for determining where riparian zone mitigation should occur. This hierarchy ensures that the mitigation project will fully compensate for any ecological loss caused by the regulated activity. The riparian zone contributes to the ecological health of both the project site and the entire watershed. Onsite mitigation, therefore, is the most efficient means for recovering all local and global benefits provided by the riparian zone. For this reason, the hierarchy dictates that mitigation must be provided on the same site as the activity where feasible.

Figure 7.1: Riparian Zone Mitigation Hierarchy



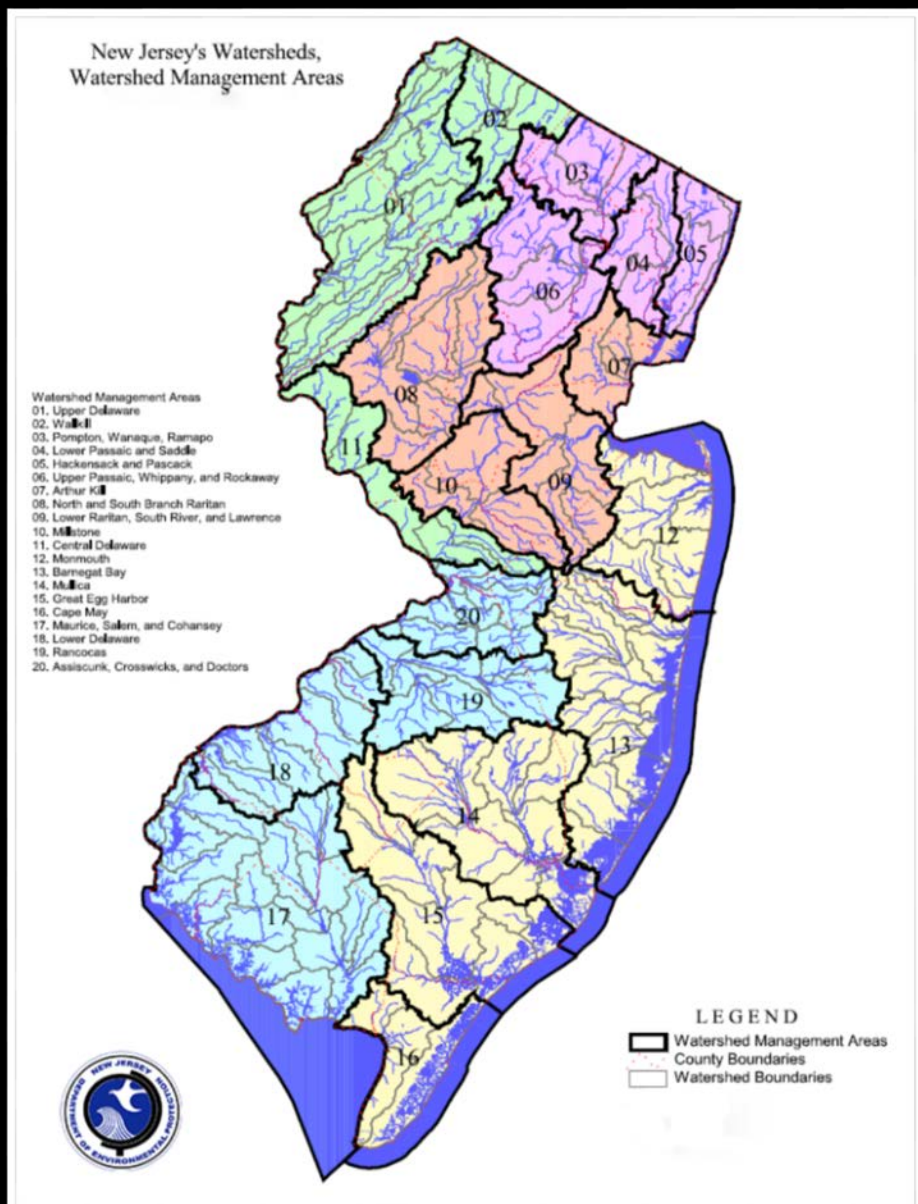
The Department recognizes that onsite mitigation is not feasible in certain instances. For example, a project undertaken within a public right of way (ROW) may not have a feasible onsite location for mitigation for a variety of reasons, such as future expansion, safety, condemnation of land, or maintenance activities.

To determine if a site is feasible for mitigation, the Department will consider the following factors:

Size	• A larger mitigation area has a greater potential for environmental benefit than a smaller one.
Location	• A mitigation area located adjacent to a large existing riparian zone complex, such as public land or another preserved area, is more likely to be environmentally beneficial than a mitigation area adjacent to land that may be subject to development.
Habitat value	• A mitigation area that will provide habitat for threatened or endangered species is more likely to be environmentally beneficial.
Interaction with nearby resources	• A mitigation area located adjacent to an existing stream, for example, enhances the environmental value of both the riparian zone and the stream.

If onsite mitigation is not feasible or cannot fully compensate for the disturbance, the Department may authorize some or all of the mitigation to be performed through the purchase of credits from a mitigation bank (see Section 7.3.5) with a service area that includes the area of impacts or to be performed offsite in the same watershed management area. New Jersey has 20 watershed management areas, which are shown in Figure 7.2. below. The Department encourages offsite mitigation to occur on the same regulated waterway as the impact or the closest regulated waterway within the same watershed management area as the regulated activity, but it must occur within the same watershed management area as the regulated activity to ensure that the mitigation fully compensates for any ecological loss. For mitigation banks, the service area of the bank will be the watershed management area where the physical bank is located.

Figure 7.2: Watershed Management Areas



Mitigation to compensate for disturbances to vegetation within a 300-foot riparian zone associated with a "major development" (defined in the Department's Stormwater Management Rules at N.J.A.C. 7:8-1.2), must occur along the same regulated water as the disturbance or along an upstream tributary to that water. See Section 6.1 for information on determining the width of the riparian zone.

When a regulated activity causes disturbance to a 50-foot or 150-foot riparian zone, mitigation activities may be performed outside the riparian zone if the mitigation project occurs on a site that is directly adjacent to the riparian zone without any intervening separation, such as a road. The project must also be located within a specified distance from the top of bank of the regulated water. For waters with a 50-foot riparian zone, the mitigation must occur within 100 feet of the top of bank, and for waters with a 150-foot riparian zone, the mitigation project must occur within 300 feet of top of bank. See Section 6.2 for information on how to determine top of bank.

7.3 How to Perform Mitigation

The FHACA Rules allow five types of mitigation:

Restoration	see Section 7.3.1
Enhancement	see Section 7.3.2
Creation	see Section 7.3.3
Preservation	see Section 7.3.4
The Purchase of Credits from a Mitigation Bank	see Section 7.3.5

One or more of these types of mitigation may be used to satisfy a mitigation requirement. For example, if the only mitigation that can be accommodated on the same site as the regulated activity is an enhancement project that does not satisfy the entire mitigation requirement, the applicant may conduct the enhancement project onsite and then purchase credits from a mitigation bank to satisfy the remainder of the requirement.

Certain types of projects will not be considered mitigation. Such projects include installing or improving an existing public facility intended for human use, such as a ball field, nature trail, or boardwalk, or installing or improving a stormwater management facility, such as a basin. Specifically, a basin that was designed to treat or manage stormwater runoff cannot also be used for mitigation.

Mitigation that is or has been performed to satisfy a requirement of a Federal, local, or other New Jersey State law, such as the Freshwater Wetlands Protection Act (FWPA) Rules, cannot also be used to satisfy the requirement for riparian zone mitigation under the FHACA Rules unless the project also meets all the requirements of these rules. While this manual does not address mitigation for wetlands under either the CZM or FWPA Rules, impacts to both a riparian zone and a wetland that occupy the same footprint can be mitigated for in the same footprint, provided the mitigation meets the standards of all applicable rules.

Regardless of the type of mitigation selected, the mitigation project must fully compensate for any ecological loss.

The Department will not approve any of the following:

- ⊗ Creation, restoration, or enhancement projects in areas of high ecological value, such as areas containing mature, dense, natural forest
- ⊗ Creation, restoration, or enhancement projects that destroy, jeopardize, or adversely modify a present or documented habitat for threatened or endangered species or jeopardize the continued existence of any local population of a threatened or endangered species
- ⊗ Creation or restoration projects that pose an ecological risk, meaning that the mitigation may result in the reintroduction of contamination to ecological communities, the exposure of humans to contamination, or the contamination of the mitigation site by subsequent exposure to new areas of contamination requiring remediation (see the Technical Requirements for Site Remediation at N.J.A.C. 7:26E-1.16 and 4.9)

Regardless of the type of mitigation selected, the mitigation project must fully compensate for any ecological loss. Therefore, the vegetation impacted by the regulated activity will usually need to be replaced by a type of vegetation that is ecologically equivalent or of greater ecological value. For example, if trees must be cut down to accommodate the activity, trees must be planted as part of the mitigation project. The Department requires the use of native, noninvasive species on all mitigation sites. It is important to note that some standardized seed mixes contain non-native species, so customized seed mixes should be purchased.

A mitigation project should also include a variety of species in a variety of sizes for the project to have the best chance at success. The success criteria for a specific riparian zone will depend on the functions performed by the impacted area. The density of the planting will also be dependent on the plant stock that will be used at the mitigation site. If an applicant chooses to use bare root stock, which often has a high mortality rate, the required planting density will probably be higher than balled and burlapped plant stock.

To ensure that mitigation fully compensates for any ecological loss, the Department recommends that all impacts and those that require mitigation be identified within the permit application and/or the mitigation proposal. Figure 7.3 below provides an example of how to report this information to the Department.

Figure 7.3: How to Report Riparian Zone Impacts Requiring Mitigation

Activity (Section 11.2)	RZ width	Total impact (square feet)	Impacts in excess of table 11.2		Forested (sq. feet)	Shrub/Scrub (sq. feet)	Herbaceous (sq. feet)	Grass/Ag (sq. feet)
(g)	150	10000	1000	Perm	4000	1000	1000	0
				Temp	3000	1000	0	0
(m)	300	8000	1000	Perm	4000	2000	1000	0
				Temp	0	0	0	

In addition, the applicant should provide a detailed description of all proposed impacts to clearly indicate the ecological functions and values of the existing riparian zone and a conclusion statement showing the amount of mitigation that is required for each regulated activity.

To determine which impacts to actively disturbed areas count towards the limits in Table 11.2, see N.J.A.C. 7:13-11.2(f) and Section 6.4.3 of this manual.

7.3.1 Restoration

Restoration mitigation involves reestablishing functions and values to a currently non-functional riparian zone. For example, a riparian zone that has been paved or a stream that has been channelized, straightened, lined, or armored does not provide the values and functions associated with a natural, vegetation-lined stream system. Removing impervious surfaces from the riparian zone, restoring natural curves to the waterway, or removing hard armoring, followed by planting the stream banks and riparian zone with native, non-invasive vegetation species, can restore the waterway and riparian zone to a more natural condition, reestablishing the functions and values of that waterway.

If restoration is the type of mitigation selected, the amount of restoration that must be performed is calculated at a 2:1 ratio, meaning two acres must be restored for every one acre that is disturbed. The Department may approve restoration at a ratio of less than 2:1 if it can be demonstrated that restoring a smaller area of riparian zone will provide the same ecological value as the riparian zone that was lost or disturbed. However, restoration will never be approved at less than a 1:1 ratio. To demonstrate equal ecological value, a survey of the conditions on the site of the disturbance and the proposed mitigation area is required along with written documentation for all of the following:

- **The existing and proposed type(s) and density of vegetation**
- **The ability of the existing and proposed riparian zones to remove sediment and pollution**
- **All proposed bank stabilization and erosion protection measures**
- **Any anticipated wildlife habitat conditions**
- **How the mitigation proposal will replace the ecological values of the lost or disturbed riparian zone**

The plan showing the current condition of the mitigation site should indicate, quantify, and describe all of the following:

- The areas of the site within the vicinity of the waterbody from which any gravel, impervious surface, or other structures and manmade materials are proposed to be removed
- The areas of a stream that will be restored to their natural geometry, sinuosity, and substrate
- The location of all proposed plantings
- The spacing of all proposed plantings

- The type of vegetation to be planted (i.e., trees, shrubs, or seeds) along with the number and size of the proposed plantings and the names of the specific species to be planted (including the content of any seed mix)

An example of how to provide the vegetation information for a proposed mitigation site is provided in Figure 7.4. This information may be depicted directly on the plan, or it may be provided separately as long as it is keyed to the plan.

Figure 7.4: How to Report Vegetation Information for a Mitigation Project

The following 10 trees are proposed:

- **5 Red Maples (Acer rubrum), three-inch caliper balled and burlapped**
- **2 Willow Oaks (Quercus phellos), three-inch caliper balled and burlapped**
- **3 Dogwoods (Cornus florida), three-inch caliper balled and burlapped**

In addition, the following 20 shrubs are proposed:

- **10 spice bush (Clethra alnifolia) #5 container**
- **5 Inkberry (Ilex glabra) #5 container**
- **5 Northern Bayberry (Myrica pennsylvanica) balled and burlapped**

Several areas will be seeded with a riparian buffer seed mix containing the following mixture:

- **30% Switchgrass (Panicum virgatum)**
- **16% Indiangrass (Sorghastrum nutans)**

All species must be native to New Jersey to be acceptable for the purposes of mitigation. Non-native landscaping plants will not be approved for planting in the riparian zone.

Restoration activities will not be approved if separated from the waterway by a roadway, railroad, or other intervening structure.

Restoration mitigation projects require monitoring (see Section 7.5) and financial assurance (see Section 7.6).

7.3.2 Enhancement

Enhancement mitigation involves making improvements to a riparian zone that is not fully functional. The riparian zone can be enhanced by removing invasive plant species and/or planting native, noninvasive vegetation of higher ecological value than the existing vegetation. Existing riparian plants may also be supplemented with additional, native, noninvasive species.

For example, a riparian zone dominated by Japanese knotweed or mugwort (which are both invasive, herbaceous plants) or by grass species subject to frequent mowing will only provide some of the functions and values associated with a riparian zone dominated by native species or a riparian zone that contains scrub shrub or forest cover in addition to herbaceous species. Replacing the Japanese knotweed or mugwort with native species or replacing the grass species with a more diverse seed mix and adding a scrub shrub or tree layer will increase the functions and values of the riparian zone.

Another example of enhancement mitigation is the planting of an understory where it can be demonstrated that the lack of an understory is causing erosion. For example, in an area that is fully forested but includes invasive species, such as Japanese knotweed or Japanese stiltgrass, along an eroding stream bank, eradicating the invasive species and replacing them with native, herbaceous shrubs or trees (e.g., live stakes in the stream banks and densely planted communities above the banks) would be considered an enhancement. However, the acreage will be calculated based on the footprint of the area being planted.

If enhancement is the type of mitigation selected, the amount of enhancement that must be performed is calculated at a 3:1 ratio, meaning that three acres must be enhanced for every one acre that is disturbed. The Department may approve enhancement at a ratio of less than 3:1 if it can be demonstrated that enhancing a smaller area of riparian zone will provide the same ecological value as the riparian zone that was lost or disturbed. However, enhancement will never be approved at less than a 1:1 ratio. To demonstrate equal ecological value, a survey of the conditions on the site of the disturbance and the proposed mitigation area is required along with written documentation for all of the following:

- The existing and proposed type(s) and density of vegetation
- The ability of the existing and proposed riparian zones to remove sediment and pollution
- All proposed bank stabilization and erosion protection measures
- Any anticipated wildlife habitat conditions
- How the mitigation proposal will replace the ecological values of the lost or disturbed riparian zone

The plan showing the current condition of the mitigation site should indicate, quantify, and describe all of the following:

- ✓ The areas of the site within the vicinity of the waterbody from which invasive plant species are proposed to be removed and/or the areas proposed for supplemental plantings
- ✓ The type of invasive species targeted for removal (such as phragmites or mugwort)
- ✓ The methods that will be used to remove the invasive species (such as herbicide application for a specified number of seasons, soil excavation, or hand removal)
- ✓ The areas of the site within the vicinity of the waterbody from which any gravel, impervious surface, or other structures and manmade materials are proposed to be removed
- ✓ The areas of a stream that will be restored to their natural geometry, sinuosity, and substrate
- ✓ The location of all proposed plantings
- ✓ The spacing of all proposed plantings
- ✓ The type of vegetation to be planted (i.e., trees, shrubs, or seeds) along with the number and size of the proposed plantings and the names of the specific species to be planted (including the content of any seed mix)

Figure 7.4 in Section 7.3.1 above provides an example of how to provide the vegetation information for a proposed mitigation site. This information may be depicted directly on the plan, or it may be provided separately as long as it is keyed to the plan.

All species must be native to New Jersey to be acceptable for the purposes of mitigation. Non-native landscaping plants will not be approved for planting in the riparian zone.

All enhancement mitigation projects require monitoring (see Section 7.5 below).

7.3.3 Creation

Creation mitigation involves restoring a natural waterway enclosed by a structure, such as a pipe or culvert, by removing the structure and reestablishing the natural bed and banks, thereby also creating a riparian zone associated with that waterway. When a stream that was once natural is enclosed within a structure, it no longer possesses a riparian zone. If the structure is removed and the stream restored to its historically natural state, the riparian zone is reestablished. Creation differs from restoration because creation refers to establishing a riparian zone where one does not currently exist while restoration refers to reestablishing the functions and values of an existing but non-functional riparian zone.

If creation is the type of mitigation selected, the amount of creation that must be performed is calculated at a 1:1 ratio, meaning that one acre of riparian zone must be created for every one acre that is disturbed. To determine the area for which credit can be granted when a stream is removed from a pipe and then restored, add together the land area between the top of banks of the restored waterway and the area of the created riparian zone associated with that waterway. See Section 6.2 of this manual for information on how to determine top of bank.

The Department may approve creation at a ratio of less than 1:1 if it can be demonstrated that creating a smaller area of riparian zone will provide the same ecological value as the riparian zone that was lost or disturbed. However, creation will never be approved at less than a 0.5:1 ratio. To demonstrate equal ecological value, a survey of the conditions on the site of the disturbance and the proposed mitigation area is required along with written documentation for all of the following:

The existing and proposed type(s) and density of vegetation

The ability of the existing and proposed riparian zones to remove sediment and pollution

All proposed bank stabilization and erosion protection measures

Any anticipated wildlife habitat conditions

How the mitigation proposal will replace the ecological values of the lost or disturbed riparian zone

For creation mitigation, the riparian zone must be restored to a natural condition free from gravel, impervious surface, or other structures and manmade materials. Some exceptions apply, such as soil bioengineering or other bank stabilization or channel restoration structures that comply with the requirements at N.J.A.C. 7:13-12.14 (see Section 12 for more information on bank stabilization and channel restoration).

The plan showing the current conditions of the site should indicate, quantify, and describe all of the following:

- All structures enclosing the regulated water that will be removed
- The geometry, sinuosity, and benthic characteristics of the channel that will be created
- Any soil bioengineering methods that will be used to restore the channel

- The areas of the site within the vicinity of the waterbody from which any gravel, impervious surface, or other structures and manmade materials are proposed to be removed
- The location of all proposed plantings
- The spacing of all proposed plantings
- The type of vegetation to be planted (i.e., trees, shrubs, or seeds) along with the number and size of the proposed plantings and the names of the specific species to be planted (including the content of any seed mix)

Figure 7.4 in Section 7.3.1 above provides an example of how to provide the vegetation information for a proposed mitigation site. This information may be depicted directly on the plan, or it may be provided separately as long as it is keyed to the plan.

All species must be native to New Jersey to be acceptable for the purposes of mitigation. Non-native landscaping plants will not be approved for planting in the riparian zone.

Creation mitigation projects require monitoring (see Section 7.5) and financial assurance (see Section 7.6).

7.3.4 Preservation

Preservation mitigation is defined as the permanent protection of undeveloped land, in its natural state, from disturbance or development through the execution of a conservation easement. In New Jersey, where much land has been developed and undeveloped land is often under the threat of development, preserving land or portions of land containing environmentally sensitive features, like streams and their attendant riparian zones, is crucial.

However, since the stream system is not enhanced when preservation is selected as the mitigation option, only suitable properties containing significant stream corridor values and functions will be accepted to satisfy a mitigation requirement. The land must be free of solid or hazardous waste and water and soil pollution. Also, the property must be currently unprotected and free of encumbrances, rights-of-way, and easements at the time that the property is proposed for preservation mitigation.

Land to be preserved to satisfy a mitigation requirement must also contribute positively to the stream and riparian zone ecosystem. To demonstrate this, the applicant must provide a narrative, maps, and any other documentation that describes the valuable features of the site. Such features may include:

- **A diversity of ecological communities**
- **Headwaters**

- **Threatened or endangered species**
- **Adjacent public, preserved lands (such as Federal wildlife refuges, State wildlife management areas, State parks or forests, or State, county, or local preservation areas)**
- **Unique aspects or characteristics that contribute to the ecological value, such as an unusual or regionally rare type of ecosystem**

For example, a forested property containing a natural stream corridor in the same watershed as the site of the proposed riparian zone impacts that also provides habitat for a threatened or endangered species may be a good candidate for preservation to satisfy a mitigation requirement for riparian zone impacts. However, if a right-of-way is present within the proposed mitigation area, the total acreage of the right-of-way must be removed from the proposed mitigation acreage because a conservation restriction cannot be placed on a right-of-way. After the right-of-way is removed from the proposed mitigation site's total acreage, the applicant will need to determine if the property still meets the requirements for preservation mitigation.

If preservation is the type of mitigation selected, the amount of land that must be preserved is determined by the Department on a case-by-case basis.

After a preservation mitigation project is approved, the permittee must demonstrate that any required conservation restriction has been recorded with each county in which the preserved land is located.

7.3.5 Purchase of Bank Credits

A mitigation bank is an operation where a mitigation bank operator restores, enhances, creates, or preserves an area of riparian zone vegetation for the purpose of selling credits to permittees who need to compensate for disturbing the riparian zone. By this method, the mitigation occurs before the regulated activity, and the permittee does not need to personally perform the mitigation activities.

As illustrated in the mitigation hierarchy (see Figure 7.1), the Department will only approve mitigation in the form of a credit purchase from an approved mitigation bank if it has determined that onsite mitigation is not feasible.

An applicant must purchase credits from a bank with a service area that includes the area of impacts. A list of available riparian zone banks is available on the Department's website at http://www.nj.gov/dep/opi/riparian-zone-banks.html.

Mitigation through the purchase of bank credits will be deemed complete once the Department receives documentation from the permittee that the credit purchase was made as well as a written certification from the mitigation bank operator indicating the number of credits purchased and the Department permit number.

7.4 Timing of Mitigation

Mitigation projects must begin either prior to or concurrently with the regulated activity, except for temporary impacts that must be completed within 6 months of completion of the regulated activity. For this reason, the Department recommends that the mitigation proposal be submitted at the same time as the permit application to ensure there is ample time to review the mitigation proposal prior to construction. If this is not possible, mitigation proposals should be submitted to the Department at least 90 days before the regulated activity is scheduled to begin.

The Department has a checklist to assist applicants in preparing a proposal for riparian zone mitigation. This checklist is located at http://www.nj.gov/dep/landuse/forms.html.

7.5 Monitoring/Success

Monitoring is required to ensure the success of all restoration, enhancement, and creation projects. After a mitigation project is complete, two types of reports are required for this purpose – the construction completion report and the annual monitoring reports.

The construction completion report serves as the baseline from which subsequent post-construction monitoring will be compared. This report must be submitted to the Department no later than 60 calendar days after the project has been completed and must include all of the following:

1. An as-built plan showing the species and densities of plantings and any grading necessary to accomplish the approved mitigation proposal
2. Photographs
3. An explanation for any deviation from the approved mitigation proposal (if applicable)

After the submission of the construction completion report, annual monitoring reports must be submitted to the Department by December 31 of each year for five years unless the Department establishes a different duration and/or frequency for these submissions. The ultimate standard for the success of any mitigation project is full compensation for any ecological loss resulting from the regulated activity. For a simple project, success may be easily determined through the full establishment of the vegetative community within five years or less. However, mitigation projects vary in complexity and some may include other factors such as changes in topography and grading, the utilization of different forms of vegetation at different stages of maturity, predation, and/or the management of invasive species. Five years may be insufficient to provide the level of assurance necessary to ensure that the required full compensation has been achieved, particularly if the site experiences problems that require corrective action.

The post-construction monitoring period begins with the first full growing season, which for the purposes of mitigation, means that the plantings have survived in the ground throughout all four seasons. For example, if a mitigation plan is fully implemented in June of 2016, the first monitoring report would be due December 2017. A growing season typically starts in March and ends in November. Since each season provides unique stresses on the plants, this first full growing season is critical for determining if they will continue to survive in the future.

The goal of all monitoring is to accurately reflect the vegetative composition of the mitigation site. Many monitoring protocols may be utilized, but successful monitoring protocols are those that set out a sampling protocol for the systematic collection of information on the herbaceous, scrub shrub, and forest layers of a site. The Department believes the key to a successful monitoring program is utilizing a plot-based monitoring structure so that the success or failure of a site can be monitored over time.

Each monitoring report must include all of the following information, as identified in Figure 7.5 on the following page:

1. An executive summary that provides the year of the monitoring and a synopsis of the impacts to the regulated areas that the mitigation is compensating for, the mitigation project, the performance standards that were to be met by that year, the monitoring results, conclusions, and any requisite corrective actions that are recommended

2. The requirements and goals stated in the approved mitigation proposal

3. A detailed explanation of the ways in which the mitigation has or has not achieved progress toward those goals

4. A list of corrective actions to be implemented and a timeline for their completion

5. A USGS quad map and an aerial photograph on which the limits of the mitigation site and all proposed access points are clearly indicated

6. Photographs of the mitigation site with a location map indicating the location and direction of each of the photographs highlighting areas that require corrective actions

7. An assessment of the planted vegetation and the species that are naturally colonizing the site, including relevant data, photographs, and field observation notes collected throughout the monitoring period
   - ❖ This should include a scientifically based assessment of the survivability of the planted vegetation, the height of planted species, a characterization of the percentage of invasive species that have colonized the site, field observations on the vigor of plants and canopy development, and an indication of any volunteer species growing on the site.

Figure 7.5 provides an example outline that could be used for a monitoring report.

Figure 7.5: Example Monitoring Report Outline

I. Introduction
   a. Project background
   b. Riparian zone restoration
   c. Purpose

II. Monitoring Program

III. Vegetation
   a. Project goals
   b. Success Criteria
   c. Description of Species

IV. Annual Monitoring Results

V. Herbaceous Cover

VI. Invasive Species Control Methods

VII. Conclusions

VIII. Photographs

IX. Appendices

Ultimately, for a mitigation project to be considered successful, the final monitoring report must demonstrate all of the following:

1. The goals of the mitigation project have been met.

2. The percent coverage of the planted vegetation in the approved mitigation proposal has been achieved.

3. The mitigation meets all applicable requirements of the FHACA Rules.

4. A conservation restriction has been executed.

The goal of monitoring reports is to document that the site is meeting or is progressing towards meeting the goals of the mitigation project. In most cases, Department review of a monitoring report includes an inspection of the mitigation site. The purpose of a site inspection following the submission of a monitoring report is to confirm the findings of the monitoring report; therefore, conducting a site inspection without the monitoring report is not appropriate. Most monitoring reports are submitted in December and January; however, conducting the site inspection during the winter months is not always feasible or practical, and the Department cannot make a thorough assessment of onsite conditions outside of the growing season.

The Department prioritizes site inspections with precedence given to:

Any site experiencing difficulties

Mitigation bank sites where the review of the monitoring report is tied to a credit release

Mitigation sites that are at the end of the required monitoring period and for which signoff has been requested

For example, if the monitoring report for the second year of a project indicates that the site is thriving, the Department may forgo a site inspection that year. On the other hand, if the monitoring report indicates that the site is experiencing some problems, a site inspection will be performed to determine what corrective actions are necessary to bring the site into compliance. A project that is not in compliance with the conditions of a permit may be referred for enforcement action at any time.

7.6 Financial Assurance

Financial assurance is a financial instrument that ensures a mitigation project will be completed in a timely fashion in the event that the permittee becomes unable or unwilling to perform the required tasks. Financial assurance must be provided for all creation and restoration mitigation projects, whether performed onsite, offsite, or by a mitigation bank. The only exceptions are mitigation or mitigation bank proposals submitted by a government agency or by an entity that is exempt under Federal law. The permittee, the mitigation bank sponsor, or the person designated to provide mitigation by an enforcement document is responsible for obtaining the financial assurance, which must be provided at least 30 calendar days before the mitigation activities begin.

The Department accepts the following types of financial assurance:

- **A fully funded trust fund**
- **A line of credit**
- **A letter of credit**
- **A surety bond**
- **Another form of financial assurance that is not self-insurance or self-guarantee**

Financial assurance templates can be found at http://www.nj.gov/dep/landuse/mitigate.html.

The amount of financial assurance will be based on an itemized estimate provided by an independent contractor (see N.J.A.C. 7:13.14(f)) and approved by the Department. An independent contractor is anyone who is not associated with the project but who has the experience and expertise to assess and itemize mitigation costs as required by the FHACA Rules.

The person responsible for providing financial assurance must post two financial assurance documents – one for construction costs and one for maintenance costs. The construction financial assurance must be equal to 115 percent of the estimated cost of completing the project. The maintenance financial assurance must be equal to 115 percent of the estimated cost of monitoring and maintaining the site, including the cost to replant the mitigation area.

The construction financial assurance will be released when the Department determines that construction (including grading and planting) of the mitigation project or bank has been successfully completed as stipulated in the approved mitigation proposal. The maintenance portion of the financial assurance may be reduced yearly as the project achieves all of its performance standards with any remaining financial assurance to be released when the Department determines that the mitigation project or bank is successful.

SECTION 8
THREATENED AND ENDANGERED SPECIES

All permits and authorizations issued under the FHACA Rules require that "the activity will not destroy, jeopardize, or adversely modify a present or documented habitat for threatened or endangered species, and shall not jeopardize the continued existence of any local population of a threatened or endangered species." Therefore, proper identification of threatened or endangered species habitat on and near a project site is necessary to determine the need to comply with the requirements for the protection of these species and their habitat. In addition, as mentioned in Section 6.1.2 of this manual, the identification of habitat for those threatened or endangered species that have been specifically identified as being "critically dependent upon the regulated water for survival," occurring onsite or up to one mile downstream, is one of several factors necessary to determine the width of the required riparian zone.

To accurately assess all effects of threatened or endangered species on a project, applicants should take the following steps:

STEP 1: Assess the possible occurrence of endangered or threatened species habitats on and near the project site (see Section 8.1).

↓

STEP 2: Determine the degree to which species "critically dependent upon the regulated water for survival" affect the width of the riparian zone (see Section 8.2). The list of critically dependent species is located at http://nj.gov/dep/landuse/download/fh_009.pdf.

↓

STEP 3: Determine if any endangered or threatened species habitats on or near the project site are protected under the FHACA Rules (see Section 8.3).

↓

STEP 4: Determine if and how the special requirements for the protection of threatened or endangered species habitat apply to the project (see Section 8.4).

Section 8.5 provides an example project.

8.1 Identifying Threatened or Endangered Species Habitats

When determining whether a subject property features an area that contains present or documented habitat for threatened or endangered species, the Department will rely on information contained in the Natural Heritage Database and New Jersey's Landscape Project mapping. The Department will also utilize any additional information relating to the presence or absence of such species or their habitat, including, but not limited to, information submitted by the applicant. Such additional information may consist of new sightings of endangered or threatened species that have been accepted by the Department's Division of Fish and Wildlife, Endangered and Nongame Species Program or the Office of Natural Lands Management, Natural Heritage Program (NHP) but have not yet been incorporated into the Landscape Project maps or the NHP's grid maps. The Department may also rely on sightings reported by the applicant or by the public to the Division of Land Use Regulation during the review of a particular application, provided the Department accepts the sightings as valid.

Applicants can obtain information on the locations of threatened or endangered species and their habitats from the following sources:

Plant Species

Information on the occurrence of habitat for threatened or endangered plant species is available from the NHP at:

State of New Jersey Department of Environmental Protection
The New Jersey Natural Heritage Program
DEP – Office of Natural Lands Management
Mail Code 501-04
P.O. Box 420
501 East State Street
Station Plaza #5, 4th Floor
Trenton, New Jersey 08625-0420
Telephone: (609) 984-1339
Natlands@dep.nj.gov
Website: www.nj.gov/dep/parksandforests/natural/heritage

Wildlife Species

Information on the occurrence of habitat for most threatened or endangered wildlife species can be found in the publication New Jersey's Landscape Project and its accompanying maps (Landscape Project maps). The Department's Landscape Project report and maps, which list the endangered and threatened species documented to occur within specific mapped habitat areas, can be viewed through the Department's interactive mapping tool at www.nj.gov/dep/gis/geowebsplash.htm and are available from the Department's Division of Fish and Wildlife, Endangered and Nongame Species Program at:

The Landscape Project
State of New Jersey
Department of Environmental Protection
Division of Fish and Wildlife
Endangered and Nongame Species Program
Mail Code 501-03
P.O. Box 420
Trenton, NJ 08625-0420
Website: www.nj.gov/dep/fgw/ensphome.htm

The Natural Heritage Database will provide information on animal species for which Landscape Project "models" have not been developed. To determine which animal species are not included in the Landscape Project, see the latest version of the mapping project.

It is crucial to note that a Natural Heritage Database response can only provide information on species of concern within a one-mile radius of a project site, and the database cannot determine if such locations are upstream or downstream of the site, which as mentioned above, can be critical for determining the width of the riparian zone (see Section 8.2 below). However, the Natural Heritage Program (NHP) grid maps may assist in the case of a rare plant species if the "S" or "Both" valued grid for the species referenced in the NHP letter is upstream of the project site. In the example shown in Figure 8.1 on the following page, the NHP letter indicated that the subject property is located within a mile of a record for Lancaster Sedge. When referring to the NHP grid maps, the grid containing Lancaster Sedge ("S" valued grid) is upstream of the subject property. Thus, this State endangered plant would not affect the width of the riparian zone at the property because the property is downstream of the record.

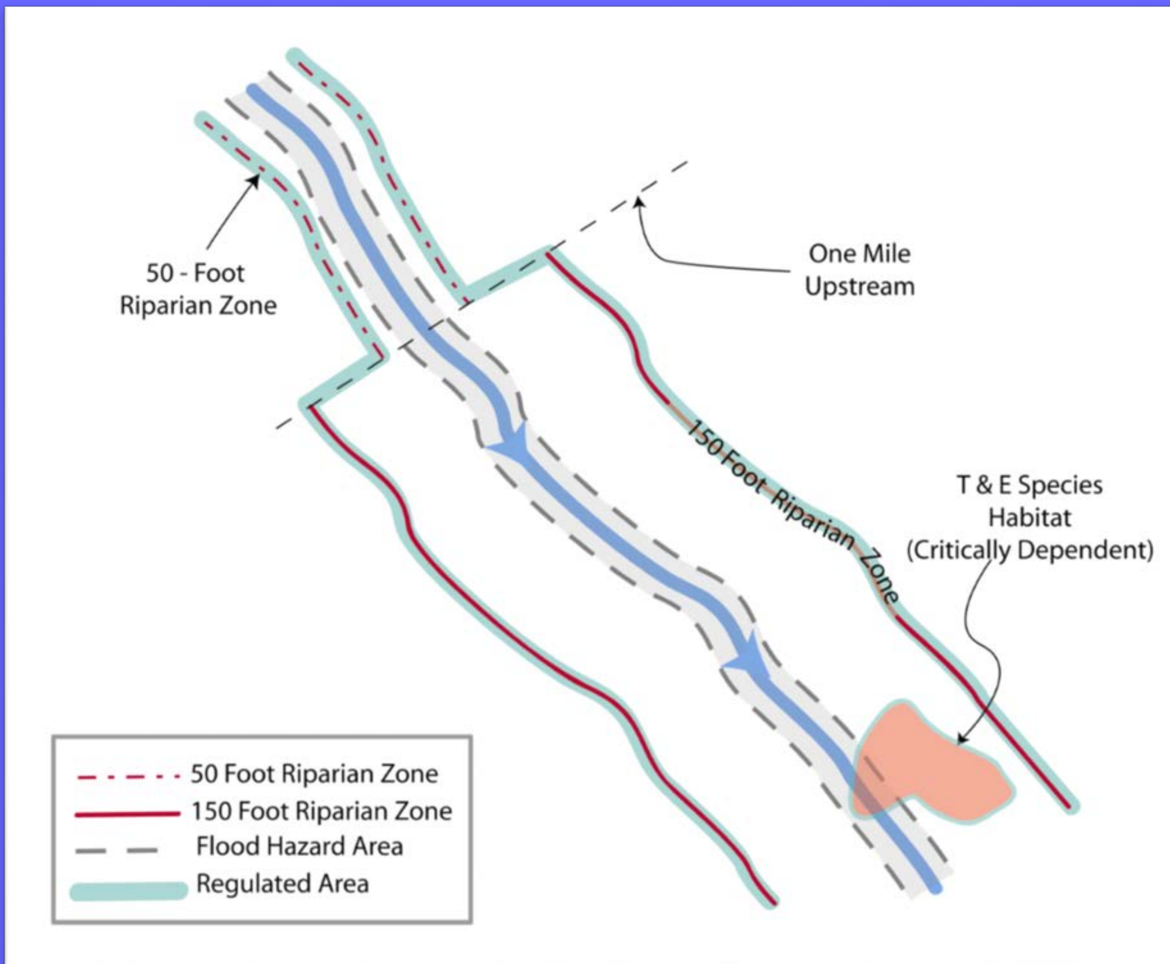
Figure 8.1: Natural Heritage Program Grid Map

In situations where the applicant is unable to determine whether a plant occurrence is upstream or downstream of the property, the applicant may request an applicability determination to ascertain if the project requires a permit or authorization under the FHACA Rules due to the presence of endangered or threatened species (see Section 2.5 of this manual for more information on applicability determinations), or the applicant may contact the Division of Land Use Regulation's Endangered and Threatened Species Unit at 609-984-0921 for additional guidance.

8.2 The 150-Foot Riparian Zone

As explained in Section 6.1.2, a 150-foot riparian zone is established along both sides of all waters flowing through areas that support threatened and endangered species that are critically dependent upon the regulated water for survival and along all tributaries within one mile upstream of the area (see Figure 8.2 on the next page). The Department has determined that an enhanced level of environmental protection is appropriate for these waters and their tributaries due to the sensitivity of threatened or endangered species to pollutants within stream corridors.

Figure 8.2: The 150-Foot Riparian Zone for Critically Dependent Species



Since the 150-foot riparian zone is applicable to tributaries within one mile upstream of trout associated waters, the rule requires the extension of the same riparian zone along upstream tributaries within one mile of waters that support threatened or endangered species that are critically dependent on the regulated water to survive.

The rules limit the waters that are provided this additional protection to those associated with threatened or endangered species that are critically dependent on the watercourse to survive because the Department has determined that these are the species that will be impacted most by disturbances to the riparian zone. The "List of Threatened and Endangered Species that are Critically Dependent on Regulated Waters for Survival" is available on the Division of Land Use Regulation's website at http://nj.gov/dep/landuse/download/fh_009.pdf.

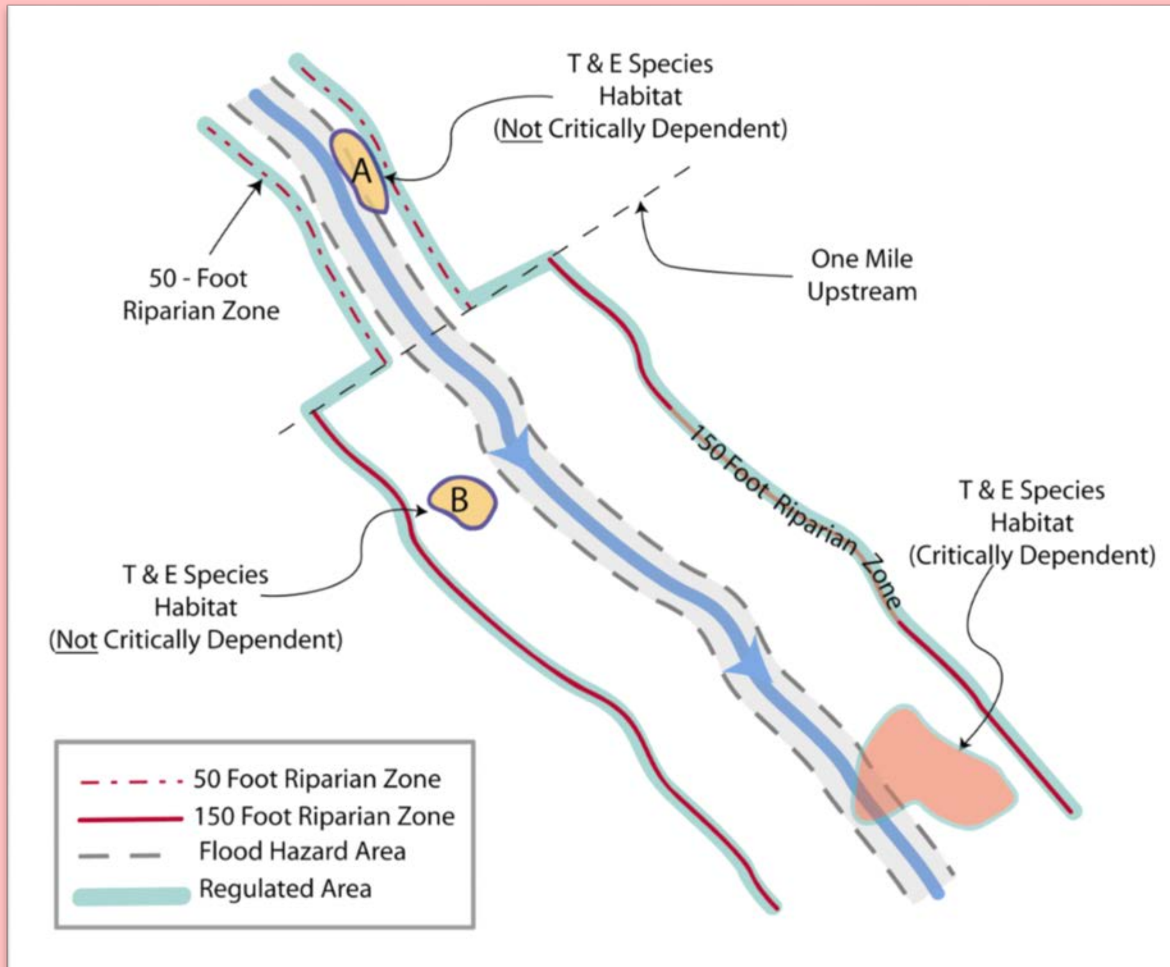
For example, bog turtle and bald eagle are both listed as endangered or threatened species. Bog turtle is listed as a species that is critically dependent on regulated waters for survival. As such, any regulated water that supports bog turtle habitat (and any regulated water one mile upstream) will have a 150-foot riparian zone (provided the water is not Category One, in which case the riparian zone would be 300 feet). In contrast, bald eagle is not listed as a species that is critically dependent on regulated waters for survival. The presence of bald eagle habitat would not, therefore, cause the riparian zone to be 150 feet wide.

This does not mean that bald eagle habitat is not protected under the FHACA Rules. While only the presence of those species that are critically dependent on regulated waters for survival will result in a 150-foot riparian zone, the FHACA Rules at N.J.A.C. 7:13-11.6(d) specify that an individual permit can be issued for a regulated activity in a flood hazard area or riparian zone only if the activity will not adversely affect any threatened or endangered species or any documented habitat for a threatened or endangered species. N.J.A.C. 7:13-6.7(b)4 contains a similar provision for permits-by-rule, general permits-by-certification, and general permits. So, while only the presence of some species will result in a 150-foot-wide riparian zone, all threatened and endangered species within the jurisdiction of the FHACA Rules are protected (see the example project in Section 8.5).

8.3 Protection of Threatened or Endangered Species Habitats

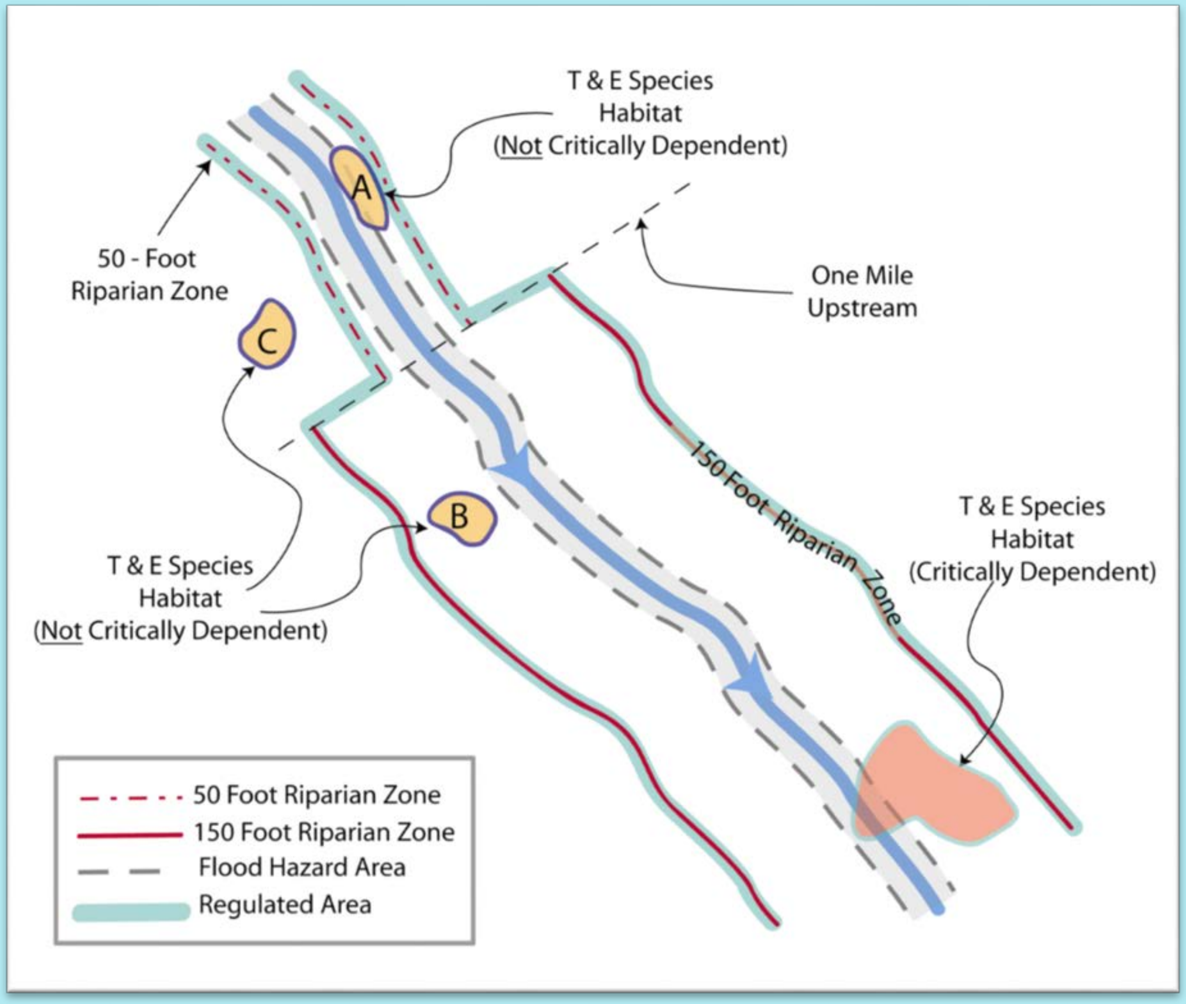
Once a present or documented habitat for threatened or endangered species has been identified on or near a project site, the applicant must determine if that habitat is protected under the FHACA Rules. As noted above, the FHACA Rules protect all present and documented habitat for threatened or endangered species that occur within the regulated areas (flood hazard area and riparian zone). Accordingly, all threatened or endangered species habitats occurring in the flood hazard area and the 50-foot riparian zone are protected. If a 150-foot riparian zone applies, even if not for a species critically dependent on the regulated water to survive, and extends into an area that contains threatened or endangered species habitat, as shown in Figure 8.3 below, that habitat falls within the regulated area and would receive protection under the FHACA Rules. The same is true of any threatened or endangered species habitats occurring within a 300-foot riparian zone.

Figure 8.3: The 150-Foot Riparian Zone and Non-Critically Dependent Species



Conversely, if a regulated activity occurs on a project site containing a threatened or endangered species habitat that is outside of a regulated area, that habitat does not benefit from protection under the FHACA Rules. The habitat must lie within a flood hazard area or riparian zone to receive any such protection. As shown in Figure 8.4 on the next page, it is possible for a threatened or endangered species habitat for a species that is not critically dependent on the regulated water for its survival to fall outside of a 50-foot riparian zone (labeled below as Habitat C) and not receive protection under the FHACA Rules (while the habitats labeled Habitats A and B would receive protection under the rules).

Figure 8.4: Determining if Threatened and Endangered Species Habitat is Protected Under the FHACA Rules

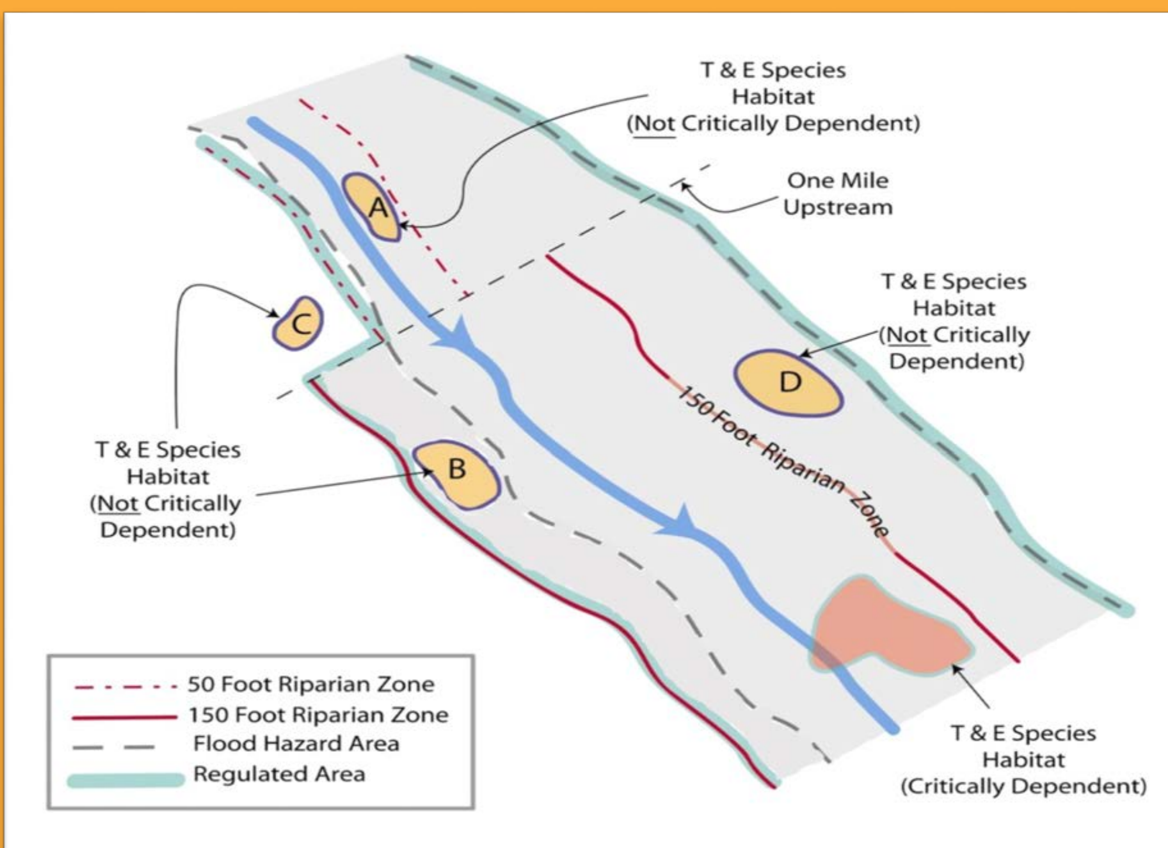


Similarly, threatened or endangered species habitat could occur just outside of either a 150-foot or 300-foot riparian zone. If this habitat was also outside of the flood hazard area, it would not be located in a regulated area and would therefore not be subject to the rules. The proper identification of the regulated area is therefore very important as it relates to the protection of threatened or endangered species under these rules.

The regulated area can vary from site to site, and the flood hazard area may even vary from one side of a regulated water to the other. As an example, shown on the following page in Figure 8.5, the regulated area extends from the edge of the riparian zone on the left side of the regulated water, across the regulated water and the width of the riparian zone on the right side of the regulated water, and ends at the edge of the flood hazard area on the right side of the regulated water. Under this scenario:

Habitat A	• Inside Flood Hazard Area • Inside 50-Foot Riparian Zone	**Protected**
Habitat B	• Outside Flood Hazard Area • Inside 150-Foot Riparian Zone	**Protected**
Habitat C	• Outside Flood Hazard Area • Outside Riparian Zone	**Not Protected**
Habitat D	• Inside Flood Hazard Area • Outside Riparian Zone	**Protected**

Figure 8.5: Threatened and Endangered Species Habitat and Regulated Areas



8.4 Requirements for Activities in Threatened or Endangered Species Habitat

All individual permit applications and most applications for verifications and authorizations under general permits must include a copy of an NJDEP, Office of Natural Lands Management Natural Heritage Database data request response for endangered or threatened species of flora or fauna, including a landscape map report, which is colloquially referred to as a "Natural Heritage letter." This letter provides information on threatened and endangered wildlife and plant species that are documented on or near the proposed project site so that Department staff can ensure compliance with the various threatened and endangered species protections afforded by the FHACA Rules. See the application checklist, as discussed in Section 3.3, to determine whether the Natural Heritage letter is required for a particular application.

The request for a Natural Heritage Letter should include a Natural Heritage Data Request Form (available at http://www.nj.gov/dep/parksandforests/natural/heritage/nhd.pdf) and all attachments. The form requires the name and address of the user/organization, the type of data needed, a copy of a USGS quad map with exact boundaries for the area of interest, and an explanation of how the information will be used. Requesters must indicate that the request is part of a FHACA Rule permit application to inform the NHP of which species should be considered in their report. Requests may take up to 30 days to be processed.

To obtain a Natural Heritage Letter, email, fax, or mail the written request to:

State of New Jersey Department of Environmental Protection
Natural Heritage Data Request Form
The New Jersey Natural Heritage Program
DEP – Office of Natural Lands Management
Mail Code 501-04
P.O. Box 420
501 E. State Street
Station Plaza #5, 4th Floor
Trenton, New Jersey 08625-0420
Phone No. (609) 984-1339
Fax No.: (609) 984-1427
Natlands@dep.nj.gov

The Office of Natural Lands Management charges a fee of $70.00 per hour for their services. An invoice with the required fee will be sent after the office provides materials. This fee is separate from the flood hazard permit fee and must be paid separately by check or money order, payable to "Office of Natural Lands Management." For more information, contact the Office of Natural Lands Management or visit the NHP's website at http://www.nj.gov/dep/parksandforests/natural/heritage/.

The protections afforded to threatened and endangered species under the FHACA Rules include N.J.A.C. 7:13-6.7, which provides the conditions that apply to all permits-by-rule, general permits-by-certification, and general permits and includes a requirement that the activity must not adversely affect a present or documented threatened or endangered species population or habitat. Therefore, if a proposed activity authorized under one of the permits-by-rule, general permits-by-certification, or general permits will adversely affect a present or documented threatened or endangered species population or habitat within a regulated area, an individual permit must be obtained for that project. The requirements that must be met for the issuance of an individual permit for a regulated activity located in a regulated area with a threatened or endangered plant or animal species or associated habitat are located at N.J.A.C. 7:13-11.6.

Specifically, N.J.A.C. 7:13-11.6(e) provides that the Department will require a survey and/or habitat assessment for threatened and endangered species if a project is likely to disturb an area known to contain a threatened or endangered species or an area containing habitat that could support a threatened or endangered species. Please note that the requirements for surveys are species specific and subject to change as new scientific information becomes available. Therefore, applicants proposing survey work should contact the Division of Land Use Regulation's Endangered and Threatened Species Unit at 609-984-0921 for further guidance. Alternatively, applicants may choose to assume the presence of endangered or threatened species habitat and submit a habitat impact assessment in lieu of a survey or habitat suitability report.

Applicants proposing SURVEY WORK for threatened or endangered species should contact the Division of Land Use Regulation's ENDANGERED AND THREATENED SPECIES UNIT at 609-984-0921 for FURTHER GUIDANCE.

Individual permit activities that are within or that will impact a threatened or endangered species habitat may be restricted during times of the year when the species is especially sensitive to disturbance, such as during mating or migratory seasons. Each activity will be permitted for at least 183 calendar days per year, but those days may not necessarily be consecutive. For example, the Department may determine that restricting activities within a threatened or endangered species habitat for three months in the spring and three months in the autumn is most effective for protecting the species in question.

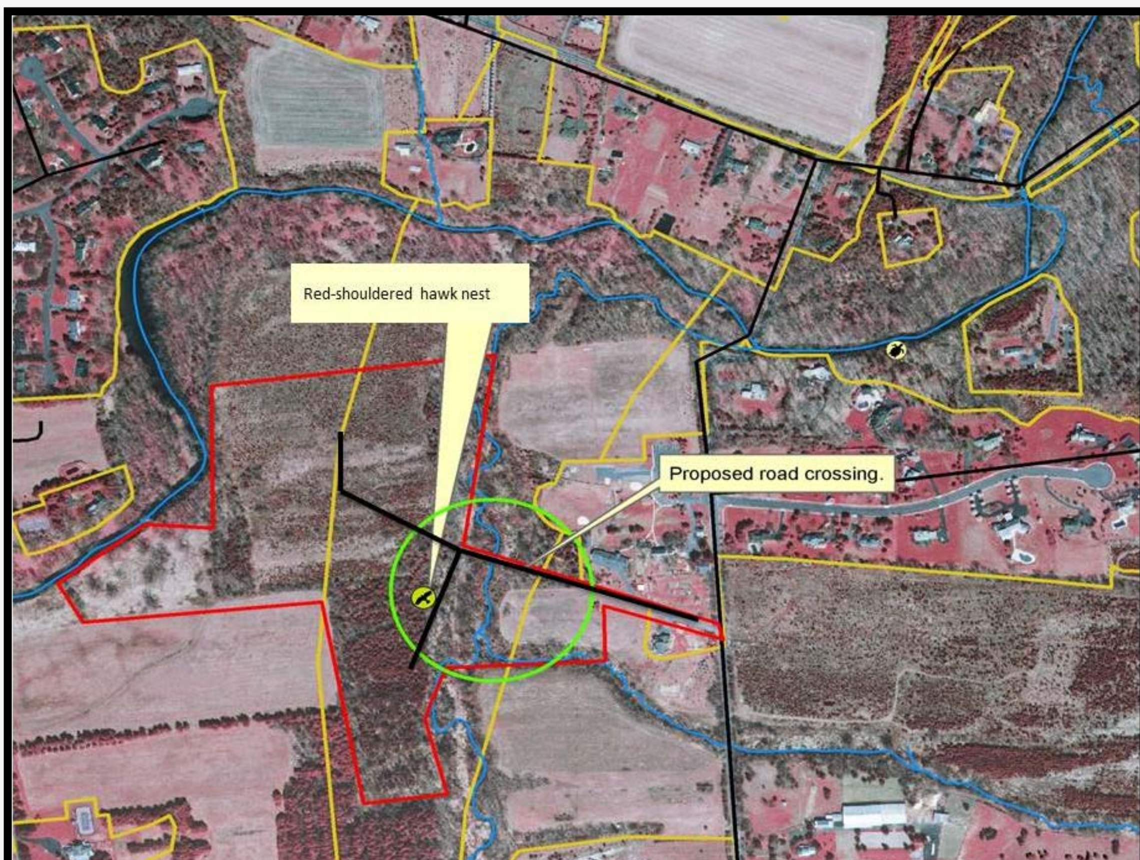
As mentioned in Section 3.1.5 of this manual, if an applicant obtains a coastal permit for a regulated activity, a separate flood hazard area approval is not needed. The Department will review the regulated activity for compliance with the FHACA Rules during the review of the coastal permit. Elements of the FHACA Rules are incorporated into the CZM Rules, such as the special area rule (N.J.A.C. 7:7-9.26, riparian zones), which establishes a riparian zone adjacent to waters that are regulated under the FHACA Rules. Under this rule, if endangered and/or threatened wildlife or plant species habitat is present in the riparian zone such that the area is also a threatened or endangered wildlife or plant species habitat special area as defined at N.J.A.C. 7:7-9.38, endangered or threatened wildlife or vegetation species habitats, the requirements of N.J.A.C. 7:7-9.38 regarding the protection of the habitat apply.

8.5 Example Project

Figure 8.6 shows a roadway that is proposed for construction near a pine grove containing a State-endangered red-shouldered hawk nest located within 150 feet of a regulated water. Although red-shouldered hawk is not critically dependent on the regulated water for survival, the riparian zone is 150 feet wide due to the presence of a different species that is critically dependent on this water. As such, the nest site is protected under the FHACA Rules.

The proposed internal roadway will result in tree removal proximate to the nest site, and since this activity could result in adverse impacts to the suitability of the nest location, an analysis of project impacts on the nest location is required. To obtain approval under the FHACA Rules, the analysis must demonstrate that the activity will not adversely affect the nest location. In this situation, it is likely that the roadway will need to be relocated. Project-specific guidance will be provided on a case-by-case basis and will rely on the particular habitat characteristics of the site.

Figure 8.6: Regulated Activity with the Potential to Adversely Affect Endangered or Threatened Species Habitat



SECTION 9 BUILDINGS

As noted previously in this manual, all structures in flood hazard areas have the potential to exacerbate flooding, displace flood storage, or be damaged by flooding. However, buildings in flood hazard areas have the additional potential to cause direct physical harm to occupants in the event of a flood. People displaced from homes damaged during floods can also experience severe economic, social, and emotional impacts for years after the event, while people trapped in homes and businesses during a flood place additional responsibilities on emergency response personnel, who are often severely burdened during flood events. Such relief efforts are generally undertaken at the expense of the general public, diverting public funds from other necessary functions and priorities of local governments. Therefore, improper construction of buildings in flood hazard areas ultimately results in increased risk of loss of life and property damage and can often lead to severe and repetitive economic losses for the Federal government, the State, and individuals.

For these reasons, buildings in flood hazard areas are subject to specific, stringent requirements under the FHACA Rules as well as other State and Federal regulations. For example, FEMA has standards for buildings that must be followed under the National Flood Insurance Program (NFIP). The Uniform Construction Code (UCC) at N.J.A.C. 5:23 also contains many standards for buildings, the relevant portions of which are incorporated into the FHACA Rules by reference, as discussed in Section 9.1.

> *IMPROPER CONSTRUCTION OF BUILDINGS IN FLOOD HAZARD AREAS ULTIMATELY RESULTS IN INCREASED RISK OF LOSS OF LIFE AND PROPERTY DAMAGE AND CAN OFTEN LEAD TO SEVERE AND REPETITIVE ECONOMIC LOSSES FOR THE FEDERAL GOVERNMENT, THE STATE, AND INDIVIDUALS.*

Buildings vary in use and size, ranging from small sheds to single-family homes to expansive warehouses. Certain smaller building projects that have minimal impact on flooding and the environment are eligible for authorization under various permits-by-rule, general permits-by-certification, or general permits. These three types of authorizations are explained in Section 3.1 of this manual. The appendices contain lists of the permits-by-rule, general permits-by-certification, and general permits arranged by category of activity, including a category for buildings (see Appendix A, Appendix B, and Appendix C, respectively).

Buildings with greater flood impact potential, or those with greater environmental impact with respect to riparian zones or threatened or endangered species, require evaluation under an individual permit. The individual permit standards under the FHACA Rules that apply to a particular building depend on the intended use and location. Standards based on location are referred to as *area-specific standards* because it is the area of siting, such as in a floodway or riparian zone, that drives the applicability of a specific regulation. The area standards for individual permits for buildings are located throughout N.J.A.C. 7:13-11, but location requirements may also apply to permits-by-rule, general permits-by-certification, and general permits. Some of these location standards are discussed in Section 9.2.

Standards based on the type of activity are called *activity-specific standards*, and the activity-specific standards for buildings are contained primarily within N.J.A.C. 7:13-12.4 (Requirements for a structure) and 12.5 (Requirements for buildings). Many of the standards located at N.J.A.C. 7:13-12.5 are discussed in Section 9.3, including requirements for the lowest floor elevation. N.J.A.C. 7:13-12.5 also includes standards for flood-proofing, which is explained in Section 9.4. Other standards for flood-resistant construction are located at N.J.A.C. 7:13-12.4 and are also described in Section 9.4. Additional requirements pertaining to access to a building during a flood are located in N.J.A.C. 7:13-12.5 and 12.6 and are discussed in Section 9.5. Finally, Section 9.6 explains the submission requirements for individual permit applications for buildings.

9.1 The FHACA Rules and the Uniform Construction Code

As mentioned above, the FHACA Rules incorporate relevant portions of the UCC by reference. For its part, the UCC incorporates the International Building Code (IBC), which references an American Society of Civil Engineers' publication entitled *Flood Resistant Design and Construction*, among other sources. The most current version of this document is commonly referred to as ASCE 24-14, and it is recognized by FEMA as meeting the minimum National Flood Insurance Program requirements for buildings. The UCC also incorporates the International Residential Code (IRC), which addresses the design and construction of one and two-family dwellings and townhouses that are no more than three stories above grade. Please note that the UCC has specific definitions of one and two-family dwellings and townhouses that may differ from the definitions in N.J.A.C. 7:13.

Prior to undertaking any regulated activity involving the construction or reconstruction of a building, the applicant should have access to the most current version of the UCC (which includes the IBC and the IRC) as well as to ASCE 24-14, which is available for download at http://www.asce.org/ for a fee. The UCC is available at http://www.state.nj.us/dca/divisions/codes/codreg/ucc.html. The IBC and IRC are available for viewing or purchase from the International Code Council at https://codes.iccsafe.org/.

The FHACA Rules reference the UCC with respect to the following:

- The required lowest floor elevation for a new, reconstructed, or improved habitable building within a flood hazard area
- The requirements for flood openings associated with proposed enclosures beneath the lowest floor of a proposed habitable building (new or reconstructed)
- The wet or dry flood-proofing of a proposed building (new or reconstructed)

Beyond these requirements, the FHACA Rules and the UCC are separate and do not regulate all aspects of buildings in the same manner. Therefore, the respective requirements of each set of standards must be considered independently. However, note that the Department's CZM Rules at N.J.A.C. 7:7 require full compliance with the UCC as well as Federal flood reduction standards at 44 CFR Part 60.

9.2 Location Requirements

The area standards for buildings are located throughout N.J.A.C. 7:13-11, including the following:

- Standards for buildings in a riparian zone at N.J.A.C. 7:13-11.2 – see Section 9.2.4
- Standards for buildings in a floodway at N.J.A.C. 7:13-11.3 – see Section 9.2.1
- Flood storage displacement requirements applicable to buildings in a flood fringe at N.J.A.C. 7:13-11.4 – see Section 9.2.2

In addition, standards regarding the proximity of structures to the top of bank are found throughout the FHACA Rules. Section 9.2.3 discusses these standards with respect to buildings. N.J.A.C. 7:13-12.5, Requirements for a building, also contains some standards that vary depending on the location of a building (for example, whether a building is located in a V zone or coastal A zone), which are discussed in Section 9.3.

9.2.1 Buildings in a Floodway

As discussed in Section 4.2 of this manual, the floodway is the inner portion of the flood hazard area where deeper and faster flood flows are expected. Buildings in floodways are in danger of significant flood damage or complete destruction during a flood event. For this reason, N.J.A.C. 7:13 places severe limitations on construction of buildings in floodways and no permit-by-rule or general permit-by-certification authorizes the construction or reconstruction of a building in a floodway.

While N.J.A.C. 7:13 prohibits most construction in the floodway, many buildings across the State already exist in a floodway and continue to be used. However, sometimes these buildings need to be repaired or even reconstructed as a result of damage caused by flooding or other factors. Because these existing buildings have remained in continued use, the FHACA Rules allow for repair and reconstruction, such as under general permit 5 (which conditionally allows for the reconstruction of a building in the floodway), provided certain stringent standards to protect public safety are met.

No new buildings are allowed in the floodway of a fluvial flood hazard area. Should a building already exist in a fluvial floodway, it may be reconstructed or repaired under an individual permit as established in N.J.A.C. 7:13-11.3 and 12.5(g) but only if both of the following apply:

1 All work is done within the same footprint so as not to cause additional obstruction.

2 The building has been occupied within five years of the date of application.

The standard for occupation within five years of the date of application highlights the seriousness of constructing in a floodway as it applies only in the floodway, not in the flood fringe. If a building in a floodway has not been occupied during that five-year timeframe, the building has been of no use for a sufficient length of time that the Department can no longer justify the additional flood hazard represented by that building. General permit 5 also cannot be used to reconstruct a building that has not been occupied within the five years prior to the date of application to the Department.

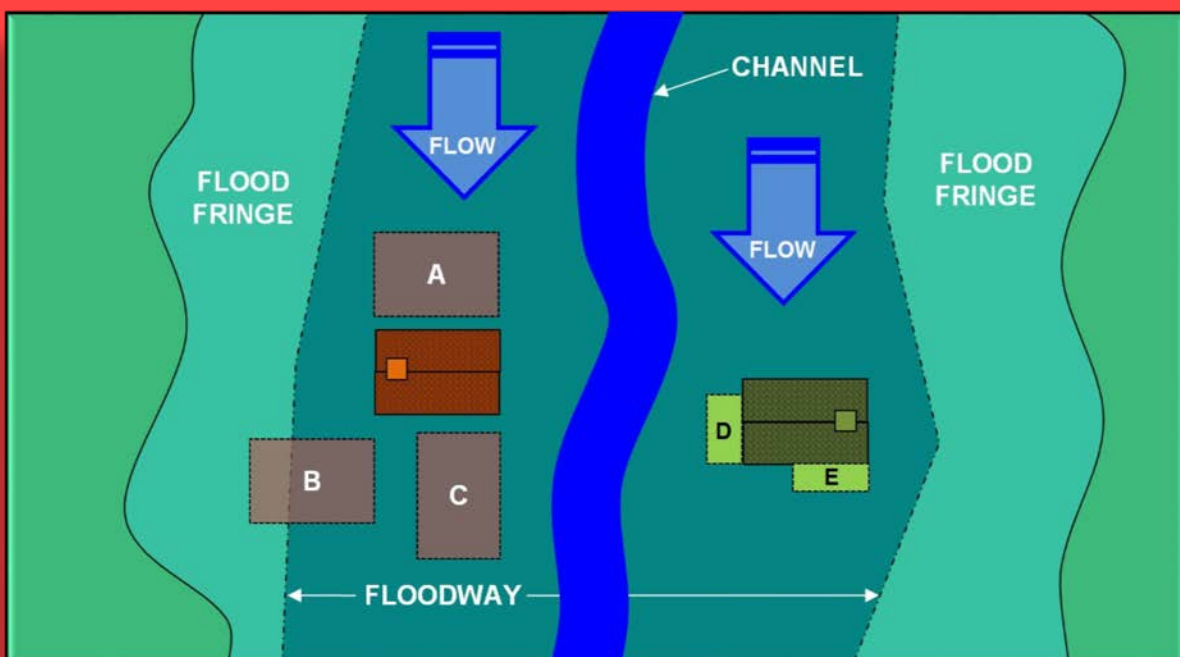
New buildings are also not allowed in the floodway of a tidal flood hazard area except as provided in very limited circumstances by N.J.A.C. 7:13-11.3(c)1. Such a building would have to comply with the CZM Rules at N.J.A.C. 7:7-9.46. Similarly, an existing building in the floodway may be converted to a residential or critical use only if it is located on a pier in the Hudson River and likewise meets the CZM Rules.

The prohibition on buildings in the floodway of either a tidal or fluvial flood hazard area also applies to buildings partially located within floodways and those that cantilever over floodways since it is not only floodwaters themselves that can damage a building. A significant source of flood damage can occur when material swept along by floodwaters, such as fallen trees, collides with structures located within or projecting either into or over the floodway. For this reason, the floodway includes the space above the design flood elevation. An applicant cannot, therefore, avoid the floodway restrictions of N.J.A.C. 7:13-11.3 by cantilevering any part of a proposed building or addition over a floodway.

For an application for an addition to a building within a floodway under an individual permit, the applicant must demonstrate that the building has been occupied within a five-year period prior to the date that the application is made to the Department under N.J.A.C. 7:13-12.5(h). Also, the applicant must prove that the addition will not result in further obstruction to flow of floodwaters and provide an engineering certification that demonstrates the building is designed to withstand the hydrostatic and hydrodynamic forces associated with flooding (see Section 9.4) to one foot above the flood hazard design flood elevation. This applies to both horizontal and vertical additions.

Figure 9.1 below shows an example of how to apply the standards for buildings in a floodway. The figure illustrates proposed relocation and addition sites and the relative potential impact on floodway flow in each case. Both the red house and green house are lawfully existing buildings located within the floodway of a regulated water. The direction of flow in this example is from the top of the figure to the bottom. Water in floodways may generally be assumed to flow roughly parallel to the direction of flow within the channel in this example. Three potential relocation sites are shown for the red house (A, B, and C) and two potential locations for an addition are shown for the green house (D and E).

Figure 9.1: Challenges of Building in a Floodway



Relocation site A is immediately upstream from the existing house. Due to the meandering of the channel and the skew of the floodway, site A appears to be slightly further from the channel and closer to the edge of the floodway than the existing house. However, in this example, the change in location is minimal, and the house in its new location would likely present the same obstruction to flow as the existing house and would therefore be acceptable under the FHACA Rules.

Relocation site B is situated downstream of the existing house and both further from the channel and partially outside the floodway. As such, site B would likely result in less obstruction to flow than the existing building. This location would generally be safer for the building itself but could present two potential problems. First, by relocating the house further from the channel, any building immediately downstream from the existing house would no longer receive the benefit of having floodwaters blocked by this house and could consequently be subject to greater flood damage potential. Therefore, relocation site B would only be appropriate if calculations are provided showing that any downstream building would not be subject to increased flood damage potential. Second, by relocating the building partially into the flood fringe, some flood storage displacement would occur (see Section 5 of this manual for an explanation of flood storage displacement). The floodway does not possess flood storage, so flood storage credit cannot be granted for the portion of the building that has been moved from the floodway into the flood fringe. The issue would likely be moot, however, since the house itself may be exempt from the flood storage displacement limitations, provided it was not part of a subdivision created after November 5, 2007 (see N.J.A.C. 7:13-11.4(d)5). Nevertheless, any grading or other fill material associated with the house would be subject to the flood storage displacement limitations of the FHACA Rules and require the creation of an equivalent volume of flood storage within the flood fringe.

Relocation site C is situated downstream of the existing house and is rotated 90 degrees from the existing orientation of the building. Due to the meandering of the channel and the skew of the floodway, site C appears to be slightly closer to the channel and further from the edge of the floodway than the existing house. By rotating the building, the cross-sectional area of its existing obstruction to flow has been reduced. Should a building be located immediately downstream, the applicant may again encounter the same scenario as described above for relocation site B. Therefore, relocation site C would only be appropriate if calculations are provided showing that any such downstream building would not be subject to increased flood damage potential.

Addition site D is closer to the channel than the existing house and appears to increase the cross-sectional area of the house's existing obstruction to floodwaters. It would therefore not meet the requirements of N.J.A.C. 7:13. The only caveat would be if this house were situated immediately downstream of a large obstruction to flow and the applicant could demonstrate that the proposed addition would not further increase the existing obstruction.

Finally, addition site E is located immediately downstream of the house and does not extend closer to the channel or closer to the edge of the floodway limit. The addition can therefore be said to lie within the "shadow" of the existing house and would therefore not likely increase the existing obstruction to flow.

9.2.2 Buildings in a Flood Fringe

Like any structure in a flood fringe, buildings displace flood storage, as described in Section 5. However, as noted in Section 5.1, the construction, reconstruction, relocation, elevation, or enlargement of one single-family home or duplex is exempt from the flood storage displacement limits in certain cases (see N.J.A.C. 7:13-11.4(d)5), including where the single-family dwelling or duplex is not constructed as part of a subdivision created after November 5, 2007. Note that if the site is regraded, this exemption will not apply to the portion of the site that is regraded. This includes any additional grading or fill that may be placed either around or under the proposed building.

Also, as stated at N.J.A.C. 7:13-11.4(j)8, the volume inside any building is considered displaced flood storage volume except for the space inside an enclosure below the lowest floor of the building (such as a crawl space) that has flood vents and otherwise conforms to the requirements at N.J.A.C. 7:13-12.5(p). See Section 9.3.3 for a discussion of enclosures below the lowest floor and Section 9.4.2 for a description of flood vents.

9.2.3 Proximity to Top of Bank

N.J.A.C. 7:13 generally prevents the clearing, cutting, and/or removal of vegetation within 25 feet of any top of bank (as discussed in Section 6.4.4 of this manual) because vegetation in this area is essential for maintaining bank stability and discouraging channel migration. Disturbing vegetation in this area can easily destabilize a channel and lead to increased erosion and flooding as well as adverse impacts to water quality. However, where a regulated water contains an existing bulkhead, retaining wall, or revetment and disturbance is limited to actively disturbed areas, the likelihood of such impacts to erosion or flooding is already minimized. As such, flexibility for activities within 25 feet of a top of bank is incorporated into the standards of a number of permits-by-rule, general permits-by-certification, and general permits. In addition, no setback requirements apply to individual permits for buildings adjacent to a lawfully existing bulkhead, retaining wall, or revetment along a tidal water. See Section 6.2 for information on how to determine top of bank.

For buildings authorized under a permit-by-rule (such as those that qualify for permits-by-rule 10, 11, 12, 13, 14, and 16), the setback requirement is 25 feet from the top of bank (unless the bank contains a legally existing bulkhead, retaining wall, or revetment along a tidal water in the project area as discussed above).

For a single-family home or duplex authorized under a general permit-by-certification 6, the building setbacks are as follows:

- 25 feet from the top of bank where the riparian zone width is 50 feet
- 75 feet from the top of bank where the riparian zone width is 150 feet
- 150 feet from the top of bank where the riparian zone width is 300 feet

See Section 6.1 of this manual for information on how to determine the width of the riparian zone.

Under general permit 6, the same setbacks apply as for general permit-by-certification 6, except the permittee must avoid disturbance with 75 feet (for a 150-foot riparian zone) or 150 feet (for a 300-foot riparian zone) to the maximum extent practicable. General permit applications are afforded limited flexibility with respect to setbacks to address site-specific circumstances.

The required setbacks for all buildings under an individual permit are as follows (unless the bank contains a legally existing bulkhead, retaining wall, or revetment along a tidal water as discussed above):

- Any new building must be located at least 25 feet from any top of bank.
- If an existing building is to be enlarged, such as through the construction of an addition, the enlarged portion of the building must be located at least 25 feet from the top of bank.
- If an existing building located less than 25 feet from the top of bank is to be elevated or reconstructed (or the proposed work constitutes a substantial improvement), the building must be relocated so that it is situated at least 25 feet from the top of bank.

If an applicant cannot comply with the standards related to additions or relocations, the applicant must:

1. Demonstrate in writing the reasons why compliance is not feasible.
2. Provide an engineering certification (as described in Section 3.3.1) confirming that the location of the proposed construction is stable and suitable for the proposed building and is not subject to erosion or undermining due to its proximity to the top of bank.

9.2.4 Riparian Zone Disturbance

Each permit-by-rule, general permit-by-certification, general permit, and individual permit for the construction or reconstruction of buildings establishes limits on the amount of vegetation that may be disturbed, either permanently or temporarily, in the riparian zone.

The permits-by-rule for the construction of a building (see Appendix A) typically limit riparian zone disturbance to a 10 or 20-foot setback around an existing structure. Many of the general permits-by-certification (see Appendix B) and general permits (see Appendix C) for buildings also include this standard, except for general permit-by-certification 6 and general permit 6. General permit-by-certification 6 is for the construction of a single-family home or duplex in a tidal flood hazard area, and general permit 6 is for the construction of the same type of project in a fluvial flood hazard area. Both of these authorizations establish hard limits on the allowed vegetation disturbance, similar to the limitations of an individual permit for a single-family home or duplex.

The requirements for riparian zone disturbance for individual permits are located in N.J.A.C. 7:13-11.2 and are discussed in Section 6.4 of this manual. These requirements include Table 11.2 (reprinted on pages 151-153 of this manual), which establishes limits on the area of riparian zone vegetation that can be cleared, cut, and/or removed without a hardship exception, additional justification, and/or mitigation. With regard to buildings, Table 11.2 makes allowances for single-family dwellings and duplexes, private driveways serving those structures, additions to those structures, and accessory structures. However, these single-family dwellings and/or duplexes cannot be part of any residential subdivision that was created on or after November 5, 2007.

For the Construction or Reconstruction of a Single-Family Home or Duplex Under N.J.A.C. 7:13-11.2(m)

In some cases, such as the reconstruction of a relatively small building, the amount of disturbance allowed for reconstruction would seem to result in a smaller building than if a new building were constructed. For example, an existing single-family home in a 150-foot riparian zone with a footprint of 1,000 square feet that is being razed and reconstructed is afforded 2,000 square feet of riparian zone disturbance under Table 11.2. This would seem to result in a house with a maximum footprint of 3,000 square feet (including any new lawn or landscaped area around the building), which is a much smaller area than the 7,000 square feet that is permitted for a new home.

As such, for the reconstruction of a single-family home or duplex, an applicant can use either the maximum area for a new single-family home/duplex or the maximum area for a reconstructed single-family home or duplex, whichever is greater. In the example above, the applicant can be permitted up to 7,000 square feet of total area (not just riparian zone disturbance) for the project (including where the existing single-family home was located). In other words, if the lot were vacant, the applicant would be able to disturb up to 7,000 square feet to construct a single-family home. The presence of a house on the lot should not diminish the area of riparian zone that the new single-family home can occupy.

Conversely, in cases where a relatively large building exists, the 2,000 square feet of riparian zone disturbance afforded under Table 11.2 for reconstruction may be the only additional disturbance allowed. For example, if a 6,000-square-foot house is being razed and reconstructed, only 2,000 square feet of additional disturbance can be permitted.

The following must also be considered for any disturbance to the riparian zone for the construction or reconstruction of any building:

1. If any building is proposed within the inner 150 feet of a 300-foot riparian zone, an alternatives analysis must be submitted as required at N.J.A.C. 7:13-11.2(d)1. Furthermore, the building must be in the public interest. See Section 6.4.5 for more information.

2. Within a 300-foot riparian zone, mitigation is required for all disturbance to vegetation. The only exceptions are for single-family homes or duplexes proposed under N.J.A.C. 7:13-11.2(m) and N.J.A.C. 7:13-11.2(n). While an individual subsurface sewage disposal system may be part

of a single-family dwelling, it is not considered an accessory structure and is instead authorized under N.J.A.C. 7:13-11.2(q). Therefore, should a single-family home need a subsurface sewage disposal system, mitigation must be provided for all disturbance associated with the construction of that system. See Section 7 of this manual for more information on mitigation requirements.

3. In certain cases, portions of a riparian zone may have existing impervious cover. For example, impervious cover may have resulted from prior development that has since been removed, such as a building foundation, or from an ongoing, continuing use, such as a parking lot. In cases where an applicant proposes a building in a riparian zone with existing impervious cover, all impervious cover within 25 feet of the top of bank must be removed and the area restored to a vegetated condition (with limited exceptions). See Section 6.4.7 for more information on this requirement.

4. In many cases, disturbance under permits-by-rule, general permits-by-certification, and general permits is limited to actively disturbed areas (lawn, gardens, and agricultural fields) or a small amount of other vegetation, depending on the type of building.

5. All temporarily disturbed vegetation must be replanted with native, non-invasive vegetation of equal or greater ecological function and value as the vegetation that was cleared, cut, or removed. An exception is made for disturbance to actively disturbed areas as well as areas where replanting would interfere with continued access to or maintenance of the building as required by Federal, State, or local law. See Section 6.4.6 for a discussion of temporary versus permanent disturbance.

6. If a proposed building exceeds the limits allowed in Table 11.2, no approval may be granted without a flood hazard area hardship exception under N.J.A.C. 7:13-15. Should the applicant qualify for a hardship exception, mitigation must be performed. However, the Department strongly discourages project designs that rely on the need for hardship exceptions. Applicants are advised to focus on site designs that fit within the limitations of N.J.A.C. 7:13-11.2, even if that means pursuing a smaller project on the site.

9.3 The Requirements of N.J.A.C. 7:13-12.5

As previously noted, many of the individual permit requirements pertaining to the construction, reconstruction, or alteration of buildings are located at N.J.A.C. 7:13-12.5. However, these requirements do not apply to all buildings that require an individual permit, as discussed in Section 9.3.1. For a building that must comply with N.J.A.C. 7:13-12.5, the standards the building must meet include standards for:

1. The elevation of the lowest floor (see Section 9.3.2)
2. Enclosures below the lowest floor (see Section 9.3.3)

N.J.A.C. 7:13-12.5 also include flood-proofing standards, which are described in Section 9.4.

9.3.1 Applicability

The standards of N.J.A.C. 7:13-12.5 apply to proposed habitable buildings located within an existing flood hazard area. N.J.A.C. 7:13-1.2 defines a *building* as any structure that is "enclosed with exterior walls or fire walls, erected and framed of component structural parts, designed for the housing, shelter, enclosure, and support of individuals, animals, or property of any kind." There are many different types of buildings, as specified in N.J.A.C. 7:13-12.5. However, for the purposes of the FHACA Rules, there are two basic types of buildings – habitable and non-habitable.

N.J.A.C. 7:13-1.2 defines a *habitable building* as any building that is intended for regular human occupation and/or residence. Examples of a habitable building include:

Single-family homes and duplexes

- Note that under N.J.A.C. 7:13-12.5(q), the Department can only issue an individual permit for the construction of a new single-family home or duplex within a fluvial flood hazard area on a lot that was created or subdivided after November 5, 2007 if none of the lots created in the subdivision contain a habitable building or possess a valid authorization from the Department to construct a habitable building in the flood hazard area. The same limitation applies to new single-family homes and duplexes in riparian zones under N.J.A.C. 7:13-11.2(m)2.

Multi-residence buildings

- These include any buildings that contain three or more units of temporary or permanent residence, such as condominiums, townhouses, apartment complexes, hotels, motels, and mixed-use buildings with three or more residential units.

Critical buildings

- These are buildings containing uses essential to maintaining continuity of government operations or supporting emergency response, shelter, and medical care functions. These include police stations, fire stations, emergency response centers, hospitals, medical clinics, and public shelters. Critical buildings are also those that serve large numbers of people, such as schools, colleges, dormitories, jails, detention facilities, day care centers, assisted living facilities, and nursing homes.

Commercial buildings

- Examples of commercial buildings include retail stores, restaurants, office buildings, or gymnasiums. Please note that a multi-use building that contains a commercial use and at least three residential units is regulated as a multi-residence building under N.J.A.C. 7:13.

Accessory structures that are regularly occupied

- Examples include garages, barns, or workshops.

Mobile and manufactured homes and trailers intended for human residence

- To be considered habitable, these structures must be set on a foundation and/or connected to utilities, such as in a mobile home park (not including campers and recreational vehicles).

Any other building that is regularly occupied

- Examples include houses of worship, community centers or meeting halls, or animal shelters that include regular human access and occupation.

Buildings not classified as habitable buildings are considered to be non-habitable buildings. Examples of non-habitable buildings include bus stop shelters, utility buildings, utility hotboxes, equipment cabinets, storage sheds, self-storage units, construction trailers meant solely for the storage of equipment, or individual shelters for animals, such as doghouses or outdoor kennels.

The distinction between habitable and non-habitable buildings is essential to the applicability of N.J.A.C. 7:13-12.5 as these standards apply only to habitable buildings, not to non-habitable buildings. However, since non-habitable buildings can be subject to and cause damage during a flood, non-habitable buildings must be designed to resist both the hydrostatic and hydrodynamic loads associated with flooding in the same way as habitable buildings (see Section 9.4 for more information on flood-resistant construction).

N.J.A.C. 7:13-12.5 also applies to buildings located in any area that was previously situated in a flood hazard area but was subject to work that resulted in the site being filled, raised, or otherwise removed from the flood hazard area after January 31, 1980 – regardless of whether the work was done in accordance with or in violation of the FHACA Rules. However, in certain situations, an area that was previously filled will not be considered part of the flood hazard area, and therefore, the requirements of N.J.A.C. 7:13-12.5 do not apply. These situations (detailed in N.J.A.C. 7:13-12.5(a)2) are as follows:

- Areas for which a Department delineation is available and the Department approves a revision of its delineation that removes the area in question from the flood hazard area (see N.J.A.C. 7:13-3.7 for revisions to delineations)
- Areas for which no Department delineation is available, but FEMA issues a Letter of Map Amendment (LOMA) that removes the area in question from the 100-year floodplain.
    - ⊗ This only applies to sites that have LOMAs as opposed to Conditional LOMAs (CLOMAs). CLOMAs are not sufficient to consider a site to be outside of FEMA's 100-year floodplain because CLOMAs are based on a proposed action instead of existing

site conditions like LOMAs. FEMA does not allow building permits to be issued based on CLOMAs because CLOMAs do not change the FEMA mapping as LOMAs do. See https://www.fema.gov/conditional-letter-map-revision for more information.

- ⊗ Where more than one FEMA map exists for a site (for example, an effective map and a preliminary map) and the site is shown to be in the 100-year floodplain on any one of those maps, the site will be considered to be within the 100-year flood plain, regardless of what the other maps indicate. Where this occurs, the construction, reconstruction, or alteration of a building remains a regulated activity under N.J.A.C. 7:13.

- ⊗ If a site was filled so that it is currently outside of the 100-year floodplain, but still remains within the flood hazard area (the flood hazard area often being larger than the 100-year floodplain), the construction or reconstruction of all or part of a building still remains a regulated activity under N.J.A.C. 7:13.

For example, consider a site mapped within FEMA's 100-year floodplain with a fluvial flood hazard area and a flood hazard area design flood elevation that is one foot higher than the FEMA 100-year flood elevation. Assume that the 100-year flood elevation is 100.5 feet NAVD, but the site is situated at elevation 101.0 feet NAVD. Because the site elevation exceeds the FEMA elevation, FEMA would issue a LOMA stating that the site is not located within the 100-year floodplain. However, because the flood hazard area design flood elevation in this case would correspond to 101.5 feet NAVD (one foot above the FEMA 100-year elevation), the site is still located below the flood hazard elevation and is subject to regulation under N.J.A.C. 7:13 despite the conclusion of the LOMA.

See Section 4.4 of this manual for more information on determining the flood hazard area limits.

9.3.2 The Lowest Floor Elevation

One of the primary concerns associated with any type of proposed habitable building is the elevation of the lowest floor. N.J.A.C. 7:13-1.2 defines the term *lowest floor* to mean:

Where any portion of a building is located within a V zone or a coastal A zone, the lowest floor elevation is measured as the bottom of the lowest supporting horizontal structural member of the building.

For any building not located within a V zone or coastal A zone, the lowest floor is measured as the top surface of the floor of the lowest enclosed area, excluding any unfinished or flood-resistant enclosure that is usable solely for vehicle parking, building access, or limited storage.

Building access is a means of accessing or entering into a building, such as a stairwell, stairway, or elevator. However, a lobby, such as for a hotel, is typically finished and provides gathering areas for people. Therefore, a lobby provides more than a means to access or enter into a building.

N.J.A.C. 7:13-12.5 requires that the lowest floor elevation be at least one foot higher than the flood hazard area design flood elevation and no lower than required by the UCC. Also, the lowest floor elevation standards under the FHACA Rules vary depending on the type of building proposed. Finally, the requirements depend on whether the project qualifies as a substantial improvement. An explanation of how to determine the lowest floor elevation is provided below followed by a list of the lowest floor requirements by building type, a discussion of substantial improvements versus repairs or additions, and some examples.

Determining Lowest Floor Elevation

Since the FHACA Rules require the lowest floor elevation to be at least one foot higher than the flood hazard area design flood elevation and no lower than required by the UCC, the lowest floor elevation required by the UCC must be determined. To do so, the applicant must know the flood design class (FDC) of a proposed building. The FDC is based on the occupancy potential of a building and the risk to the public if that building were to incur damage or otherwise fail as a result of a flood. There are four flood design classes, labelled 1 through 4. Buildings with the lowest risk are assigned to FDC 1, and buildings with the highest risk are assigned to FDC 4.

To determine the FDC, refer to ASCE 24 or to the Department of Community Affair's Construction Code Communicator, which is available for download at http://www.nj.gov/dca/divisions/codes/publications/ccc.html and reprinted on the next page as Figure 9.2. Note that the source material must always be checked to ensure that the most updated information is utilized at the time application is made to the Department.

ONCE THE REQUIRED UCC ELEVATION IS DETERMINED, IT MUST BE COMPARED WITH AN ELEVATION EQUIVALENT TO ONE FOOT ABOVE THE FLOOD HAZARD AREA DESIGN FLOOD ELEVATION. THE HIGHER OF THE TWO ELEVATIONS WILL SERVE AS THE REQUIRED LOWEST FLOOR ELEVATION UNDER THE FHACA RULES.

After the FDC is known, the flood zone designation (e.g., A zone, coastal A zone, or V zone) and FEMA's base flood elevation need to be determined from FEMA mapping, located at https://msc.fema.gov/portal. Once the FDC, flood zone designation, and base flood elevation are known, the UCC's required lowest floor elevation can be determined from a chart found in ASCE 24 and in the Construction Code Communicator, which is reprinted in Figure 9.3 on page 209. Refer to this documentation to ensure that the most updated information is used.

Once the required UCC elevation is determined, it must be compared with an elevation equivalent to one foot above the flood hazard area design flood elevation. The higher of the two elevations will serve as the required lowest floor elevation under the FHACA Rules. Some examples are provided below. See Section 4.6 for information on how to determine the design flood elevation.

Figure 9.2: ASCE 24's Flood Design Classification System

(2015 I-Code Flood Hazard Construction – DEP Revisions – Update)

ASCE 24-14 Table 1-1, Flood Design Class of Buildings and Structures

Category	Use or Occupancy of Buildings and Structures
1	Buildings and structures that normally are unoccupied and pose minimal risk to the public or minimal disruption to the community should they be damaged or fail due to flooding. Flood Design Class 1 includes: (1) temporary structures that are in place for less than 180 days; (2) accessory storage buildings and minor storage facilities (does not include commercial storage facilities); (3) small structures used for parking of vehicles; and (4) certain agricultural structures. [Note (a)]
2	Buildings and structures that pose a moderate risk to the public or moderate disruption to the community should they be damaged or fail due to flooding, except those listed as Flood Design Classes 1, 3, and 4. Flood Design Class 2 includes the vast majority of buildings and structures that are not specifically assigned another Flood Design Class, including most residential, commercial, and industrial buildings
3	Buildings and structures that pose a high risk to the public or significant disruption to the community should they be damaged, be unable to perform their intended functions after flooding, or fail due to flooding. Flood Design Class 3 includes: (1) buildings and structures in which a large number of persons may assemble in one place, such as theaters, lecture halls, concert halls, and religious institutions with large areas used for worship; (2) museums; (3) community centers and other recreational facilities; (4) athletic facilities with seating for spectators; (5) elementary schools, secondary schools, and buildings with college or adult education classrooms; (6) jails, correctional facilities, and detention facilities; (7) healthcare facilities not having surgery or emergency treatment capabilities; (8) care facilities where residents have limited mobility or ability, including nursing homes but not including care facilities for five or fewer persons; (9) preschool and child care facilities not located in one- and two-family dwellings; (10) buildings and structures associated with power generating stations, water and sewage treatment plants, telecommunication facilities, and other utilities which, if their operations were interrupted by a flood, would cause significant disruption in day-to-day life or significant economic losses in a community; and (11) buildings and other structures not included in Flood Design Class 4 (including but not limited to facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released. [Note (b)]
4	Buildings and structures that contain essential facilities and services necessary for emergency response and recovery, or that pose a substantial risk to the community at large in the event of failure, disruption of function, or damage by flooding. Flood Design Class 4 includes: (1) hospitals and health care facilities having surgery or emergency treatment facilities; (2) fire, rescue, ambulance, and police stations and emergency vehicle garages; (3) designated emergency shelters; (4) designated emergency preparedness, communication, and operation centers and other facilities required for emergency response; (5) power generating stations and other public utility facilities required in emergencies; (6) critical aviation facilities such as control towers, air traffic control centers, and hangars for aircraft used in emergency response; (7) ancillary structures such as communication towers, electrical substations, fuel or water storage tanks, or other structures necessary to allow continued functioning of a Flood Design Class 4 facility during and after an emergency; and (8) buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing sufficient quantities of highly toxic substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released. [Note (b)]

Note (a) - Certain agricultural structures may be exempt from some of the provisions of this standard; see ASCE 24-14 Section C1.4.3.
Note (b) - Buildings and other structures containing toxic, highly toxic, or explosive substances shall be eligible for assignment to a lower Flood Design Class if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in ASCE 7-10 Section 1.5.3 of Minimum Design Loads for Buildings and Other Structures that a release of the substances is commensurate with the risk associated with that Flood Design Class.

Figure 9.3: The UCC's Required Lowest Floor Elevations

		IRC[a]	IBC[b]			
			Cat 1	Cat 2	Cat 3	Cat 4
A zone	Elevation of the lowest floor[c]	BFE +1 ft	BFE +1 ft	BFE +1 ft	BFE +1 ft	BFE +2 ft
Coastal A zone and V zone	Elevation of the bottom of lowest supporting horizontal structural member of lowest floor[c]	BFE +1 ft	BFE +1 ft	BFE +1 ft	BFE +2 ft	BFE +2 ft

Lowest Floor Requirements by Building Type

As mentioned above, lowest floor elevation requirements under N.J.A.C. 7:13 vary depending on the type of building proposed. For reference, differences between the FHACA Rules and the UCC are noted in italics.

New Buildings (N.J.A.C. 7:13-12.5(i))

- The lowest floor of a single-family home, duplex, or critical building must be set at least one foot above the flood hazard area design flood elevation and no lower than the elevation required by the UCC. Single family dwellings and duplexes most commonly fall within Flood Design Class 2 while a critical building may fall within Flood Design Classes 3 or 4.

- Except as noted below, the lowest floor of a multi-residence building must be set at least one foot above the flood hazard area design flood elevation and no lower than the elevation required under the UCC. A multi-residence building typically falls within Flood Design Class 2. Should the multi-residence building have a lobby, its floor must be elevated because a lobby provides more than simple access to a building as mentioned above.

  Exception: Any non-residential portions of a mixed use building (such as a retail use on the first floor) should be elevated in accordance with the residential portions of the building, but if it is not feasible to do so, the non-residential portions may, with sufficient justification, be placed at lower elevations, provided that the lowest floor is elevated as much as feasible, the low portions are flood-proofed in accordance with UCC standards, and no portion of the building is located within a V zone or coastal A zone. The only exception is for enclosures below the flood elevation for sites within the coastal A zone where an architect or engineer certifies that the foundation is UCC compliant. Such certification needs to include an explanation of how UCC compliance is achieved and needs to be included in any application to the Department.

- The lowest floor of all other buildings must be set at least one foot above the flood hazard area design flood elevation and no lower than the elevation required under the UCC. If this is not feasible, these buildings can be flood-proofed provided the applicant can demonstrate that it is not feasible to properly elevate the lowest floor. However, basements are not allowed under any circumstances (see N.J.A.C. 7:13-12.5(p)2).

  Unlike the FHACA Rules, no demonstration of infeasibility is required before the lowest floor of a non-residential building is placed below the flood elevation and flood-proofed under the UCC.

Legally Existing Buildings Substantially Damaged by Fire, Flooding, or Other Natural Disaster (N.J.A.C. 7:13-12.5(j))

- The lowest floor of the entire building must meet the requirements for a new building *to the extent feasible*. Where it is not feasible to build to the required lowest floor elevation, no single-family home, duplex, critical building, or residential portion of a multi-residence building may have a lowest floor elevation set below the FEMA 100-year flood elevation.

- Any existing basement must be eliminated.

- Enclosures below the lowest floor must be open to floodwaters and have flood vents that meet UCC requirements.

Substantial Improvements to Legally Existing Buildings that are Not a Result of Substantial Damage (N.J.A.C. 7:13-12.5(k))

- The lowest floor of any constructed, elevated, enlarged, or modified portion of the building must meet the requirements for a new building.

- The lowest floor of the remainder of the building must meet the requirements for a new building *to the extent feasible*. Where it is not feasible to build to the required low floor elevation, no single-family home, duplex, critical building, or residential portion of a multi-residence building may have a lowest floor elevation set below the FEMA 100-year flood elevation.

- Any existing basement must be eliminated.

- Enclosures below the lowest floor must be open to floodwaters and have flood vents that meet UCC requirements.

Legally Existing Buildings that are Not Substantially Improved (N.J.A.C. 7:13-12.5(l))

- The lowest floor of any constructed, elevated, enlarged, or modified portion of the building must meet the requirements for a new building. E*levating the lowest floor is not required under the UCC.*
- The lowest floor of the remainder of the building does not need to be modified, meaning an existing basement may remain.
- Enclosures below the lowest floor of the new construction must be open to floodwaters and have flood vents. No new or expanded basements are permitted.

Buildings Built in Violation of N.J.A.C. 7:13 (N.J.A.C. 7:13-12.5(m))

- The building must be modified as necessary to meet the lowest floor requirements of N.J.A.C. 7:13.

Buildings Converted into a Single-family Home, Duplex, Multi-residence Building, or Critical Building (N.J.A.C. 7:13-12.5(n))

- The building must be modified as necessary to meet the lowest floor requirements for a new building, as listed above. *Where such work does not constitute a substantial improvement, the UCC will not require the applicant to elevate the lowest floor. See the explanation of substantial improvements below.*

Substantial Improvements vs. Repairs or Additions

As previously mentioned, for lowest floor elevation requirements, not only is the type of building important but the exact nature of the proposed project matters (i.e., whether the project represents a substantial improvement). While both the FHACA Rules and the UCC distinguish between substantial improvements and building repairs or building additions, the regulations are not the same.

As defined in N.J.A.C. 7:13-1.2, a *substantial improvement* is any reconstruction, rehabilitation, addition, or other improvement where the cost of the improvement is at least 50 percent of the market value of the existing structure prior to the start of work. When a project for an existing building qualifies as a substantial improvement, the entire building, and not just the proposed improvement, must comply with the lowest floor standards of N.J.A.C. 7:13-12.5. If a project does not qualify as a substantial improvement, only the proposed improvement needs to comply with the FHACA Rules. Note that the UCC requirements for the lowest floor elevation apply only to proposed buildings and substantial improvements, not to other building alterations, such as additions.

The Department relies upon accepted methodology to determine market value and cost of construction. FEMA's IS-9 publication, located at https://www.fema.gov/floodplain-management-old/substantial-improvement, discusses managing development in flood hazard areas and is part of FEMA's National Flood Insurance Program. Refer to this document for the most up-to-date and detailed information.

The following are acceptable methods to determine the market value of an existing building:

- An independent appraisal made by a professional appraiser, provided the appraisal excludes overall land value
- The cash value of a building
- The appraisal for property tax assessment purposes, provided the municipal tax appraiser reviews and, if necessary, adjusts the appraisal
- NFIP claims data
- The judgement of the local building department or tax assessor's office (When such judgement is relied upon, documentation in support of that judgement should be forwarded to the Department for review.)

No matter which of the above methods are used to determine market value, the market value must be current at the time of application to the Department, and the applicant must provide documentation as evidence that the provided market value is current.

With regard to project cost, project cost estimates must be prepared by either a licensed general contractor or a professional construction estimator. All material, labor, overhead, and profit are considered in the evaluation of project cost as described in FEMA publication IS-9. These are typically considered to be hard costs. However, the following, which are considered soft costs, may not count toward project costs:

- The cost of preparing plans and specifications
- Surveying
- Permit fees
- Demolition work
- Repairs to structures not associated with the building, including exterior fences, posts, and walls

As part of application submitted to the Department, the applicant needs to include documentation consistent with the above project-cost guidelines to demonstrate whether a proposed construction activity will result in a substantial improvement or substantial repair of an existing building.

The standards for evaluating substantial improvements do not apply to historic buildings, as defined by FEMA, in certain cases, including:

- Structures that are listed in the National Register of Historic Places or that otherwise meet the requirements for individual listing
- Structures that contribute to the historic significance of a registered historic district
- Structures that are listed on either a State or local inventory of historic places

To be exempt from the lowest floor requirements associated with a substantial improvement or substantial repair, the proposed construction needs to maintain the continued historic designation of the existing building, meaning that proposed construction cannot negatively impact or destroy the historic character of the existing building. In such a case, the exemption would no longer be applicable, and the existing building would have to comply with all applicable regulations in the same manner as any other proposed building.

Examples

Example 1

A site is adjacent to a watercourse with a tidally controlled flood hazard area. No Department delineation exists, but FEMA has published a flood study for the watercourse. FEMA's 100-year base flood elevation is 10 feet NAVD, and the site is not located within an area where there is wave action (i.e., the V zone or coastal A zone). A new residential building with a designation of FDC 2 is proposed. According to ASCE 24, the required lowest floor elevation of the IRC is one foot above the base flood elevation. In this example, the required lowest floor elevation would be 11 feet NAVD. The required elevation of the IBC is also one foot above the base flood elevation, which also equates to 11 feet NAVD. Therefore, the required lowest floor elevation of the UCC is 11 feet NAVD.

Since there is no Department delineation upon which to rely and FEMA's flood hazard area is tidally controlled, the base flood elevation is the flood hazard area design flood elevation. Therefore, the flood hazard area design flood elevation is 10 feet NAVD. At least one foot above this elevation (11 feet NAVD) is required for a new residential building under the FHACA Rules, which happens to match the UCC requirements. Therefore, the required lowest floor elevation for the proposed residential building is 11 feet NAVD, which is measured at the top surface of the floor since the building is outside of a V zone or coastal A zone.

Example 2

An elementary school is proposed within a tidally controlled flood hazard area. The only source of flood mapping is FEMA mapping, and the base flood elevation is 10 feet NAVD. The site is located within the coastal A zone. According to ASCE 24, the required lowest floor elevation of the IRC is one foot above the base flood elevation, which equates to an elevation of 11 feet NAVD. However, for the IBC, the required lowest floor elevation is two feet above the base flood elevation, which equates to an elevation of 12 feet NAVD. The UCC's required lowest floor elevation is the higher of the two elevations, which is 12 feet NAVD. In addition, because the site is located in the coastal A zone, the lowest floor elevation must be measured from the bottom of the lowest horizontal structural floor member, as opposed to the top surface of the floor.

Since there is no Department delineation upon which to rely and FEMA's flood hazard area is tidally controlled, the base flood elevation is the flood hazard area design flood elevation. Therefore, the flood hazard area design flood elevation is 10 feet NAVD. At least one foot above this elevation (11 feet NAVD) is required for a new critical building under the FHACA Rules.

Since the UCC requires a higher elevation, the UCC elevation is used to establish the minimum required lowest floor elevation for this example. Therefore, the lowest horizontal structural floor member must be constructed at or above 12 feet NAVD.

Example 3

A site is in a fluvial flood hazard area (therefore not in any coastal A or V zone, which are only present in tidally controlled areas), and a single-family dwelling is proposed. Both a Department delineation and FEMA study exist. The Department delineation shows a flood elevation of 103 feet NAVD while FEMA's 100-year flood elevation is 100 feet NAVD.

The proposed dwelling is FDC 2, and the IRC requires the lowest floor elevation to be one foot higher than FEMA's base flood elevation. This equates to 101 feet NAVD.

To determine the regulatory flood hazard design flood elevation, one foot is added to FEMA's base flood elevation, which equates to 101 feet NAVD. However, the Department delineation indicates an elevation of 103 feet NAVD. Since the Department delineation has the higher of the two elevations, that information will be used (see Section 4.6 of this manual for more details on determining the design flood elevation). At least one foot higher than the flood hazard area design flood elevation (104 feet NAVD) is required for a new single-family dwelling under the FHACA Rules. Therefore, the required lowest floor elevation is 104 feet NAVD. Because the site is not located in a coastal A zone or a V zone, the lowest floor is measured at the top surface of the floor, as opposed to the lowest horizontal structural floor member.

9.3.3 Enclosures Below the Lowest Floor

Since N.J.A.C. 7:13 requires that buildings be elevated, people often wish to enclose the area beneath the lowest floor for safety reasons and aesthetics as well as to create storage or parking areas. As per N.J.A.C. 7:13-12.5(p), such enclosures are permissible provided:

- The enclosure is used solely for parking of vehicles, building access, or storage.
- The floor of the enclosure is situated at or above the adjoining exterior grade along at least one entire exterior wall in order to provide positive drainage of the enclosed area.
- The enclosure is constructed with permanent flood openings that meet the requirements of the Uniform Construction Code at N.J.A.C. 5:23.
- Where the enclosure is greater than six feet in height, the deed for the lot on which the enclosure is constructed is modified to provide certain information on the depth and frequency of flooding as well as to prevent habitation of the area.

The only exception is a building located in a coastal A or V zone. No enclosures below the lowest floor of a habitable building are allowed if the building is located either partially or wholly in the V zone. Similarly, no enclosures below the lowest floor elevation are allowed in the coastal A zone unless an architect or engineer certifies that the foundation is UCC compliant. In this case, any application for an enclosure below the lowest floor must include this certification, and the certification must specifically document how the foundation complies with the UCC.

In addition, under the NFIP, foundations that offer minimal resistance to waves and floodwaters passing beneath elevated buildings (such as pile and column foundations) are required in V zones and coastal A zones. Coastal waves and flooding can exert strong hydrodynamic forces on any building element that is exposed to waves or the flow of water. Standard foundations, such as solid masonry or concrete or wood-frame walls, will generally obstruct flow and be at risk of damage from high-velocity flood forces. In addition, these solid foundations can cause wave run-up or reflection and divert floodwaters into elevated portions of the building or into adjacent buildings. Use of structural fill (screened earthen material used to create a base strong enough to support a structure) to support buildings in V zones and coastal A zones is generally prohibited under the NFIP because such fill will be subject to erosion during a flood event, which will generally result in structural damage to, or catastrophic failure of, the affected buildings.

Basements (enclosed areas where all sides are below grade) are prohibited in flood hazard areas. Additionally, where an authorization or permit is required to reconstruct or elevate a building, N.J.A.C. 7:13 requires that existing basements below the affected portion of the building be removed.

Whether a building is located fully or only partially within a flood hazard area, no portion of a proposed, reconstructed, substantially repaired, or substantially improved building may have a basement, even if the basement is limited to the portion of the building that is not located in the flood hazard area. Once a portion of a building encroaches into the flood hazard area, N.J.A.C. 7:13 regulates the entire building as a building within the flood hazard area.

Finally, any enclosure below the flood elevation must be flood-proofed, which is discussed further in Section 9.4 below.

9.4 Flood-Resistant Construction and Flood-Proofing

While the safest location for a building is outside of the flood hazard area, this is not always feasible. For buildings within the flood hazard area, proper design and construction is essential to protect people and property from the negative impacts of flooding. The requirements at N.J.A.C. 7:13-12.4 that apply to all structures require all buildings, whether habitable or non-habitable, to be able to resist both the hydrostatic and hydrodynamic forces associated with flooding. Otherwise, the building risks structural failure. Its walls might buckle, and it may even collapse.

Hydrostatic loads, forces, or pressure refer to the pressure exerted by static floodwaters on a building at a given elevation due to the force of gravity. Water weighs 62.4 pounds per cubic foot, and hydrostatic pressure increases with the depth of floodwaters. During a flood, the walls of a building can therefore be subject to thousands of pounds of force due to hydrostatic pressure. *Hydrodynamic loads, forces, or pressure* refer to the loads that result from the momentum of floodwaters flowing against and around a building. Hydrodynamic pressure on a building increases with both the depth and velocity of floodwaters.

Specific and detailed standards related to flood-resistant construction of buildings can be found in the Uniform Construction Code. The FHACA Rules require buildings to adhere to the UCC standards for flood-resistant construction. One method for flood-resistant construction is flood-proofing.

As defined at N.J.A.C. 7:13-1.2, *flood-proofing* refers to measures applied to a building that are intended to prevent or provide resistance to displacement, buoyancy, and damage from flooding up to a certain elevation to eliminate or reduce potential flood damage to the building and its contents. There are two types of flood-proofing:

- Dry flood-proofing (explained in Section 9.4.1)
- Wet flood-proofing (explained in Section 9.4.2)

Flood-proofing standards differ in the FHACA Rules and the Uniform Construction Code. The UCC allows an applicant to either elevate or flood-proof a building, regardless of feasibility of construction or cost. However, under N.J.A.C. 7:13, flood-proofing is only appropriate for certain buildings where elevating the lowest floor to the required elevation is not feasible. However, in cases where it is neither difficult nor costly to elevate the lowest floor of a building, flood-proofing is not allowed under the FHACA Rules.

SINGLE FAMILY HOMES, DUPLEXES, CRITICAL BUILDINGS, AND RESIDENTIAL PORTIONS OF MULTI-RESIDENCE BUILDINGS MUST BE SUITABLY ELEVATED AND CANNOT BE FLOOD-PROOFED.

For example, many single-family homes in flood hazard areas are constructed on pilings, a construction technique that permits floodwaters to pass beneath the lowest floor of the building while ensuring the habitable area of the building is not subject to flood damage. However, it may not be possible to construct a different type of building on pilings. A commercial warehouse, for example, is typically built on a concrete slab due to the weight of the materials being stored inside. Elevating such a building could be cost prohibitive. Alternately, filling in a site to raise its grade above the design flood elevation can also be cost prohibitive and may result in excessive flood storage displacement (which is prohibited in fluvial flood hazard areas under N.J.A.C. 7:13-11.4). In such cases, it may be more cost effective to construct the lowest floor of the building at elevations below the flood hazard area design flood elevation and dry flood-proof the warehouse to prevent floodwaters from entering.

Under N.J.A.C. 7:13-12.5, flood-proofing is appropriate only for certain non-residential buildings and non-residential portions of multi-residence buildings. Proposed single-family homes, duplexes, critical buildings, and residential portions of multi-residence buildings (and any additions to these buildings) cannot be flood-proofed and must instead be constructed so that the lowest floor lies at least one foot above the design flood elevation and no lower than required under the UCC. The requirements for flood-proofing can be found at N.J.A.C. 7:13-12.5(r) through (u).

9.4.1 Dry Flood-Proofing

Dry flood-proofing refers to measures that prevent floodwaters from entering a building. Dry flood-proofing generally includes making the building watertight through sealing openings, installing waterproof doors and windows, or sealing walls with waterproof coatings, impermeable membranes, and/or a supplementary layer of masonry or concrete.

Dry flood-proofing measures include:

- Walls designed strong enough to resist hydrostatic and hydrodynamic pressure so that they will not buckle or collapse during or as a result of a flood event

- Removable reinforcements for doors and windows that are deployed upon receipt of flood warnings

Under N.J.A.C. 7:13, any building that is to be dry-flood-proofed through either of these measures must meet the dry flood-proofing requirements of the UCC and must be designed and constructed to prevent floodwaters from entering the building up to a flood depth of at least one foot above the flood hazard area design flood elevation. The structure should therefore be watertight below this elevation with walls that are substantially impermeable to the passage of floodwaters. Attendant utilities and sanitary facilities must also be completely flood-proofed below this elevation.

As per the UCC, dry flood-proofing measures are not permitted in V zones or coastal A zones where flood velocities are calculated to exceed five feet per second. The UCC mandates that, regardless of flood zone designation, any building proposed to be dry flood-proofed must have at least one exit door or emergency escape situated above the dry flood-proofed elevation. For the purposes of N.J.A.C. 7:13, this elevation is equivalent to one foot above the flood hazard area design flood elevation, not the base flood elevation. In addition, flood emergency plans and actions must be posted in at least two conspicuous locations at the building to be dry flood-proofed.

The Department strongly recommends that occupants of dry flood-proofed buildings hold flood safety drills, similar to common fire drills.

If dry flood-proofing measures require human intervention to implement, such as the placement of flood planks or other barriers installed by hand, these types of flood-proofing measures are acceptable under the UCC only where there is a minimum warning time of 12 hours in advance of a flood. The only exception is where a community warning system is already in place that provides a different warning time sufficient to implement the dry flood-proofing measures. The Department strongly recommends that occupants of dry flood-proofed buildings identify individuals who will be in charge of implementing the flood-proofing measures and periodically hold flood safety drills, similar to common fire drills.

An additional consideration that should be taken into account when using dry flood-proofing is that losses to a building can be catastrophic if a flood exceeds the building's design parameters. While N.J.A.C. 7:13-12.5 requires that buildings be flood-resistant to only one foot above the design flood elevation, a larger flood could seriously damage or destroy the building and its contents.

9.4.2 Wet Flood-Proofing

Wet flood-proofing refers to measures that allow floodwaters to enter a building and thereby balance hydrostatic pressure on the structure during a flood. Wet flood-proofing generally includes using flood-resistant materials, protecting mechanical and utility equipment, and using openings or breakaway walls.

Wet flood-proofing measures include:

- Permanent openings in the walls of a building, such as flood vents, that allow water to freely enter and exit the structure

  These measures must be designed to allow for automatic entry and exit of floodwaters.

- Construction using flood resistant materials below the design flood elevation that are easily cleaned after a flood event

While dry flood-proofing endeavors to prevent floodwaters from entering the structure, the purpose of wet flood-proofing is to allow floodwaters to enter so as to balance water levels inside and outside the building and thereby relieve hydrostatic pressure on the building's exterior walls. The advantage of wet flood-proofing is that the structural integrity of the building is preserved during a flood, at least as it pertains to hydrostatic forces. The disadvantage is that the interior improvements and contents of the building are not protected from flooding and are subject to damage and the development of unhealthy conditions, such as mold. However, flood damage can be reduced by using flood resistant construction materials, such as tile flooring as opposed to wood or carpet. For these reasons, the UCC does not permit the use of materials such as wood or carpet where wet flood-proofing is proposed.

The FHACA Rules will only allow the use of wet flood-proofing for areas above the lowest floor of a building where both of the following apply:

- ✓ Elevating the lowest floor as required by N.J.A.C. 7:13-12.5 is not feasible
- ✓ The applicant demonstrates that it is not feasible to dry flood-proof the building.

Like dry flood-proofing, wet flood-proofing must be undertaken in accordance with the UCC, which limits wet flood-proofing to a small subset of buildings, including the following:

- Attached garages or parking, access, and storage areas below the design flood elevation
- Certain historic buildings, accessory structures, buildings functionally dependent on proximity to water, and agricultural buildings

Flood vents or hydraulic openings are a common type of wet flood-proofing measure. The UCC establishes specific standards for flood vents that must be met for any proposed project where wet flood-proofing is proposed and a flood hazard permit is required. These standards are as follows:

- A minimum of one square inch of net open area is required for each square foot of enclosed area for non-engineered openings. The net open area is equivalent to that area that is open to passage of floodwaters and does not include the area of any type of screening or other obstruction covering the opening.

- A minimum of two vents are required per enclosed area, and the vents must be located on at least two different sides of the exterior walls.
- The bottom of the flood vent opening must not be higher than 12 inches above the adjacent grade. Similarly, the entire opening must be below the 100-year flood elevation.
- The opening in the wall must be at least 3 inches in diameter.

Engineered vs. Non-Engineered Flood Vents

There are two types of flood vents – engineered flood vents and non-engineered flood vents. The latter is the most basic and the least expensive. Removing a concrete block from a typical block foundation is an example of a non-engineered flood vent. While engineered flood vents are costlier, they provide greater flood-proofing over the same area. With a typical, non-engineered flood vent, the area of the net effective opening in square inches must be greater than or equal to the area of the enclosure in square feet. For example, a typical concrete block has a net area of 128 square inches and therefore provides enough flood-proofing for an enclosure that is 128 square feet or less in size. Engineered vents, on the other hand, are rated for a certain amount of enclosed area that is always greater than the net area of the opening. In the same 128-square-inch foundation opening, some engineered vents can provide adequate flood-proofing for a 200-square-foot enclosure. Since the same opening in the foundation will flood-proof a larger area, fewer engineered flood vents are required than non-engineered flood vents, which is often preferable for a number of reasons, including aesthetics, structural integrity, and construction costs.

9.5 Access During a Flood

As discussed previously in this manual, N.J.A.C. 7:13 provides a number of requirements intended to reduce the likelihood of flood damage to buildings (as well as damage from buildings) by establishing various stringent design and construction standards. These requirements also help ensure that occupants of buildings are protected to the maximum extent possible from injury and loss of life during a flood event. An important corollary to these stringent building standards is the suite of requirements in N.J.A.C. 7:13 that are intended to ensure that people, as well as emergency responders, can get into and out of buildings during a flood. These standards help minimize the likelihood that people will be trapped in buildings and provide a means for emergency response personnel to access the building and its occupants during a flood event, forming an important safety measure to serve the public interest.

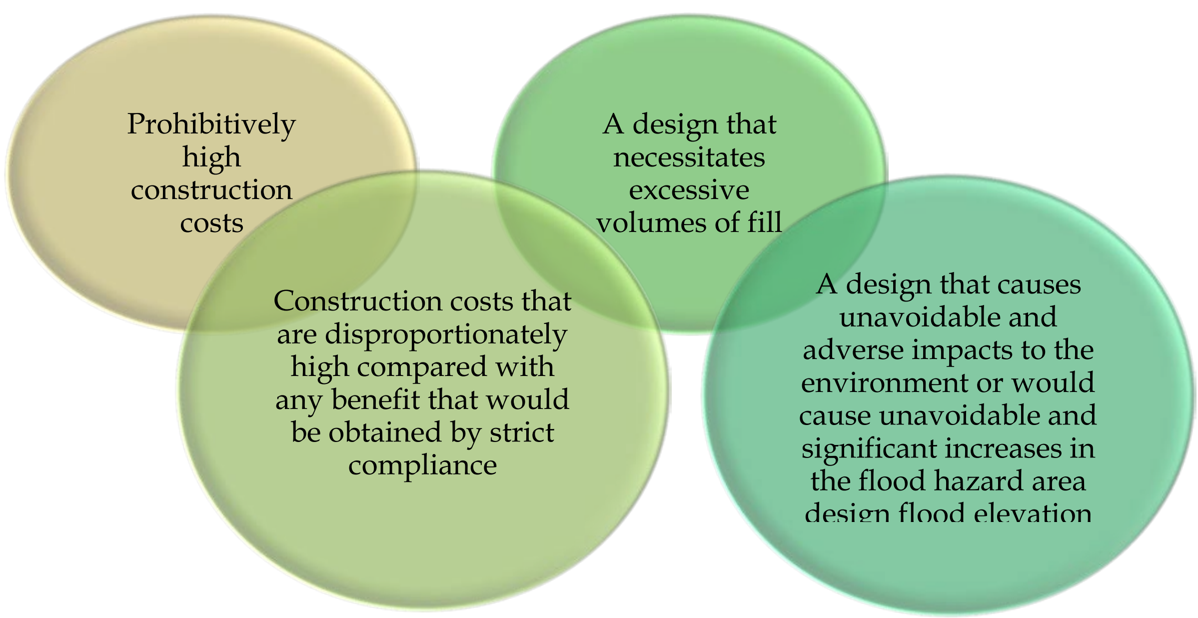
The FHACA Rules contain access requirements that must be met to construct a building, which are discussed in Section 9.5.1. They also contain requirements for private roadways and parking areas serving different types of buildings that apply regardless of whether the roadways or parking areas are constructed at the same time as the building, which are discussed in Section 9.5.2.

Given the importance of access to and from a building, as well as having functional roadways during times of flood, the Department strongly recommends that applicants take all measures to ensure that all proposed roadways and parking areas are elevated.

9.5.1 Requirements for a Building Related to Access

N.J.A.C. 7:13-12.5(o) establishes the requirements for access to a multi-residence building or a critical building (either new construction or conversion of an existing building to one of these uses). These requirements must be met for the Department to issue an individual permit for the building itself.

To receive a permit under the FHACA Rules, critical buildings and multi-residence buildings that are not part of a redevelopment project in fluvial areas must be served by at least one existing or proposed roadway, the travel surface of which is constructed at least one foot above the flood hazard area design flood elevation. There is some flexibility for critical buildings and multi-residence buildings in tidal flood hazard areas and for multi-residence buildings that are part of a redevelopment project in fluvial flood hazard areas. In these cases, the building must be served by at least one existing or proposed roadway, the travel surface of which is constructed at least one foot above the flood hazard area design flood elevation, unless the applicant demonstrates that such access is not feasible due to:



Under N.J.A.C. 7:13-12.6(e), the applicant must also demonstrate that every reasonable effort has been made to situate portions of any new or reconstructed roadway at least one foot above the flood hazard area design flood elevation. Also, the applicant must demonstrate that the building being served by roadways less than one foot above the flood hazard area design flood elevation will not pose an extraordinary risk, by providing the following:

- ❑ An analysis of the depth and frequency of floodwaters that will inundate the railroad, roadway, or parking area
  - ~ Note that the travel surface of a private roadway or parking area that serves a multi-residence building in a fluvial flood hazard area may not be situated more than 12 inches below the flood hazard area design flood elevation under any circumstances.

- ❑ The number of people that will be adversely impacted when the roadway serving the building is inundated by floodwaters

- ❑ Measures proposed to ameliorate the anticipated adverse impacts, such as the establishment of evacuation plans for individuals who would be trapped during a flood, provisions for emergency electrical service during an outage, and flood-proofing measures (see Section 9.4)

- ❑ An adequate number of permanent signs that are posted in prominent locations indicating which roadways are subject to flooding

9.5.2 Requirements for Roadways and Parking Areas Serving Different Buildings

N.J.A.C. 7:13-12.6 contains requirements that must be met when constructing or reconstructing private roadways and parking areas, depending on the type of building the roadways or parking areas will serve.

Critical buildings and multi-residence buildings that are not part of a redevelopment project in fluvial flood hazard areas must be served by at least one existing or proposed roadway, the travel surface of which is constructed at least one foot above the flood hazard area design flood elevation. If any roadways serving these types of buildings are proposed to be constructed or reconstructed, they must be at least one foot above the flood hazard area design flood elevation unless the applicant demonstrates that the building is already served by a properly elevated roadway. In such a case, any new roadway must be constructed as close to this elevation as feasible.

Private roadways and parking areas serving all other buildings, such as driveways serving single-family homes and roadways and parking areas serving multi-residence buildings that are part of a redevelopment project in fluvial areas, must be elevated one foot above the flood hazard area design flood elevation unless the applicant demonstrates this is not feasible. The requirements for demonstrating that this is not feasible are the same as those for access roads listed in Section 9.5.1.

In any situation where a roadway or parking area is constructed less than one foot above the flood hazard area design flood elevation, the deed for each lot on which the private roadway or parking area is constructed (as well as any lot served by the private roadway or parking area) and the lease or rental agreement for a unit within a multi-residence building served by a private roadway or parking area that lies below the flood hazard area design flood elevation must be modified to inform occupants that the roadway and/or parking area is likely to be inundated by floodwaters, which may cause damage and/or inconvenience. The deed and/or lease must also disclose the depth of flooding that the private roadway or parking area would experience during the FEMA 100-year flood, if available, and the flood hazard area design flood. In addition, warning signs must be placed where the roadway or parking area serves a critical building or multi-residence building and where a parking area has ten or more spaces to ensure users are aware of potential flood risk.

9.6 Submission Requirements

For individual permit applications for building projects submitted under the FHACA Rules, the following materials are required (each of which is discussed further below):

- Engineering drawings
- An engineering report
- An environmental report

Engineering Drawings

The following information must be submitted on one or more drawings:

- Plan view of the site in the existing condition
- Vertical datum
- Existing topography and a depiction of existing land cover and structures
- Any riparian zone limits
- Any flood hazard area limits, floodway limits, or V zone or Coastal A zone designations

In addition, a plan view of the proposed condition is required, showing all of the following:

- The proposed building footprint, including the footprint of a building that has already been designed.
    - Note that it is not sufficient to show a maximum footprint of a building or a conceptual design. Without a designed building, the Department cannot verify that the proposed

building meets applicable design standards. Substituting notes on a plan in lieu of a building design cannot be accepted as notes do not enable a review for compliance.

- Proposed topography
- Proposed disturbances to vegetation in the riparian zone, which must be shaded and quantified
- The proposed lowest floor elevation
- The elevation and proposed use of any and all enclosed areas below the lowest floor elevation

Where, flood-proofing is proposed, the drawings must show the proposed flood-proofing techniques as follows:

- Where wet flood-proofing is proposed, the location and number of proposed flood openings must be shown in plan view. A detail of the openings must also be provided on the plans. The detail must be drawn to scale and must show the elevation of the proposed flood openings.
- Where dry flood-proofing is proposed, the plan view must show every location where dry flood-proofing techniques (flood barriers, etc.) are proposed. A detail must also be provided and it must show the elevation to which the technique is proposed.

Finally, drawings must show:

- The elevation and extent of any proposed driveways, drive aisles, access roads, parking areas, and/or accessory structures
- Flood storage displacement volume cross sections and cross section locations where applicable.

All drawings must be signed and sealed by a New Jersey licensed professional engineer, land surveyor, or architect, as appropriate, unless both of the following apply:

- The applicant proposes the construction of a single-family home or duplex or an accessory structure, such as a patio, garage, or shed on his or her own property for his or her own use.
- The proposed regulated activity or project is one for which no survey, topography, or calculations are necessary to demonstrate compliance with the requirements of the FHACA Rules.

Engineering Report

The required engineering report (discussed in Section 3.3.2) must show all relevant calculations associated with a building. These may include (but are not limited to) flood storage displacement calculations (see Section 5), structural stability calculations for dry flood-proofing techniques, and/or calculations that determine the number and size of proposed flood openings. The report must also contain one copy of the flood study (Department delineation, FEMA mapping, Approximation Method, or Calculation Method), as described in Section 4.4, used to determine the lowest floor elevation of the proposed building. In many cases, the applicant may apply for a verification concurrently with the permit application. In these cases, the applicant should provide all information necessary for a verification, summarized in Section 3.2.

The report must contain a narrative that explains the underlying assumptions of any and all calculations submitted in conjunction with the application. The narrative must also describe in detail how the proposed building complies with each applicable requirement of N.J.A.C. 7:13.

Environmental Report

The required environmental report, described in Section 3.3.3, must address all relevant requirements of N.J.A.C. 7:13-11.2 for riparian zone disturbance. At a minimum, the report must quantify the amount of proposed disturbance to vegetation in the riparian zone and contain a narrative describing with how such disturbance has been minimized.

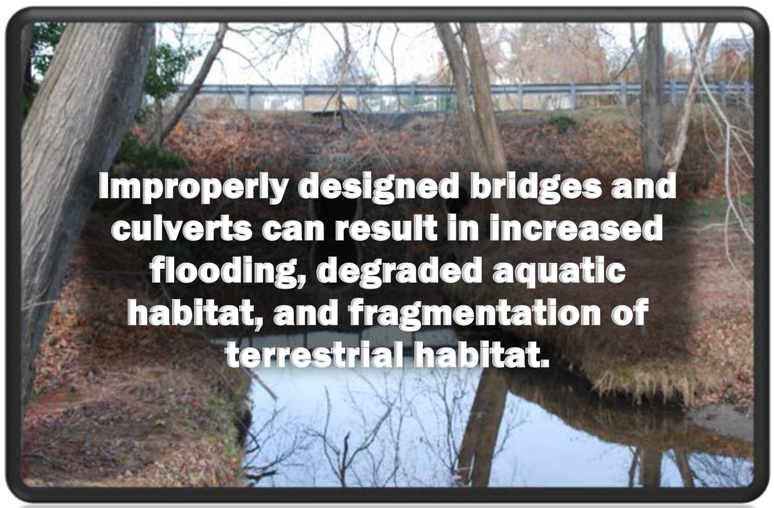
Where mitigation is required, the report must detail the proposed mitigation plan (if known at the time of submittal) or at a minimum, acknowledge the amount of mitigation that is required. Details concerning riparian zone mitigation are located in N.J.A.C. 7:13-13 and discussed in Section 7 of this manual.

In addition to demonstrating compliance with the appropriate riparian zone standards, the environmental report must also document how the proposed building will not adversely impact any threatened or endangered species (see N.J.A.C. 7:13-11.6 and Section 8 of this manual).

SECTION 10
BRIDGES AND CULVERTS

A watercourse's *hydraulic capacity*, or its ability to convey water, depends on its cross-sectional area, roughness, shape, and slope, and the presence or absence of obstructions. The construction of a bridge or culvert on the watercourse may alter one or more of these characteristics, which could cause a significant change in the hydraulic capacity of the watercourse or its floodway. Altering hydraulic capacity can lead to increased flooding. If a proposed bridge or culvert reduces the hydraulic capacity of the channel, flooding upstream of the structure can increase. On the other hand, if a bridge or culvert significantly increases hydraulic capacity, floodwaters will be able to pass through the structure at a quicker rate, and increased downstream flooding can occur.

If improperly designed and constructed, a bridge or culvert can also obstruct the passage of aquatic species and can otherwise degrade aquatic habitat by introducing sediment and other pollutants into waters, thereby impeding the species' ability to feed and reproduce. In addition, an improperly designed structure may fragment terrestrial habitat, which can be just as environmentally damaging. For these reasons, the construction, reconstruction, rehabilitation, and removal of bridges and culverts are regulated activities under the FHACA Rules, and a permit or authorization is required when these activities are undertaken along regulated waters (see Section 2.1 for information on how to determine if a water is regulated).



Section 10.1 explains the types of flood hazard authorizations and permits available for bridges and culverts. Section 10.2 discusses the various hydraulic standards that apply to any project involving a bridge or culvert while Section 10.3 explains the requirements and considerations for a hydraulic analysis. Section 10.4 discusses the standards necessary to protect aquatic species and habitat that may be impacted by bridge or culvert projects, and Section 10.5 addresses the issue of habitat fragmentation of terrestrial species. Finally, Section 10.6 describes some of the limitations for bridges and culverts with respect to riparian zone disturbance.

10.1 Available Permits and Authorizations

A variety of authorizations and permits are available for the construction, repair, reconstruction, and removal of bridges and culverts under the FHACA Rules. Section 3.1 of this manual provides general information about the different types of permits and authorizations.

Depending on the size and scope of the project, a bridge or culvert may qualify for one of the authorizations under a permit-by-rule, general permit-by-certification, or general permit described below. If the project does not qualify for one of these authorizations, an individual permit is required. Note that the permits-by-rule, general permits-by-certification, and general permits are not available if the proposed project constitutes a major development as defined by the Stormwater Management Rules at N.J.A.C. 7:8 (see N.J.A.C 7:13-6.7(c)).

The individual permit requirements for a bridge or culvert are located at:

N.J.A.C. 7:13-11.1 through 11.6	Area-specific requirements
N.J.A.C. 7:13-12.1	Requirements that apply to all regulated activities
N.J.A.C. 7:13-12.2	Requirements for stormwater management
N.J.A.C. 7:13-12.4	Requirements for a structure
N.J.A.C. 7:13-12.6	Requirements for railroad, roadway, and parking area
N.J.A.C. 7:13-12.7	Requirements for a bridge or culvert

Many of these standards, particularly the standards found in N.J.A.C. 7:13-12.7, are discussed in detail in Sections 10.2 through 10.5. Section 10.6 provides information on the riparian zone standards at N.J.A.C. 7:13-11.2 that apply to bridges and culverts. For information on stormwater management, see Section 14.

Permits-by-Rule

Permits-by-rule (which are described in Section 3.1.1) are available for the following activities related to bridges and culverts:

Repair work along a bridge or culvert	Permit-by-rule 2
The construction of a footbridge	Permit-by-rule 23
The reconstruction of the superstructure of a bridge where activities are sufficiently limited in their impacts	Permit-by-rule 42

Permit-by-rule 2 (located at N.J.A.C. 7:13-7.2) authorizes repair of a bridge or culvert. *Repair*, as defined in N.J.A.C. 7:13-1.2, means that less than 50 percent of a bridge or culvert is replaced and that its size, shape, or location is not altered. When repair includes replacement, to determine the amount of replacement, the area of the structure along which work is proposed must be compared to the total area of the structure, and these areas must be examined from both a plan view and a cross-sectional view. If the area of work measures less than 50 percent of both the plan view *and* cross-sectional view, it is considered a repair. Otherwise, the proposed work is considered to be a replacement, and the project is not eligible for this permit-by-rule.

Permit-by-rule 23 (located at N.J.A.C. 7:13-7.23) authorizes the construction of a footbridge, provided that the ground elevation near the bridge is not raised to provide access to the bridge.

Permit-by-rule 42 (located at N.J.A.C. 7:13-7.42) authorizes the in-kind replacement of a bridge superstructure that lies below the flood hazard area design flood elevation. To be considered *in-kind*, as defined at N.J.A.C. 7:13-1.2, the bridge's location, orientation, physical dimensions, and hydraulic capacity cannot be altered. As such, the proposed superstructure must have the same dimensions as the existing one – the proposed high and low chord elevations must match the existing elevations. Similarly, the out-to-out length of the superstructure must be the same in both the existing and proposed conditions. Finally, the materials constituting the superstructure should not be changed in the proposed condition. If they are changed, the new materials must be hydraulically equivalent to the existing ones. In cases where existing parapets or curbing act as an effective weir, a proposed increase in road profile below the elevation of that existing effective weir would still result in a classification as an in-kind replacement because such minor alterations will not, by inspection, result in an alteration of the hydraulic capacity of the bridge.

Refer to the applicable rule text for all of the specific requirements that must be met for a project to qualify for each permit-by-rule.

General Permits-by-Certification

General permits-by-certification (which are described in Section 3.1.2) are available under limited circumstances for the following activities related to bridges and culverts:

The in-kind replacement of a culvert	General permit-by-certification 10
The in-kind replacement of any public infrastructure	General permit-by-certification 15
The construction of a footbridge	General permit-by-certification 16

General permit-by-certification 10 (located at N.J.A.C. 7:13-8.10) authorizes an in-kind culvert replacement subject to a number of conditions. The same requirements to meet the definition of *in-kind* that were discussed above for permit-by-rule 42 apply to this general permit-by-certification. Also, note that this general permit-by certification may only be utilized if the culvert being replaced was not removed more than one year prior to the date of its replacement. If a culvert washed out or was otherwise removed more than one year before a replacement structure is scheduled to be constructed, a general permit or individual permit would be necessary.

General permit-by-certification 15 (located at N.J.A.C. 7:13-8.15) authorizes the in-kind replacement of any public infrastructure, including a bridge or culvert, provided that the structure was damaged in a flood or other weather event that led the Governor of New Jersey to declare a State of Emergency or FEMA to declare a major disaster. If no such declarations were made, this general permit-by-certification is not available. Also, any work authorized by this general permit-by-certification must commence within 180 calendar days of the declaration and be completed within 180 calendar days of issuance of this general permit-by-certification.

General permit-by-certification 16 authorizes the construction of a footbridge that meets the criteria in N.J.A.C. 7:13-8.16. These criteria are intended to minimize environmental impacts. The limitations on width and thickness, and the upstream elevation requirements, allow a determination that the footbridge will not cause offsite flooding without the need to review engineering calculations for each use of the permit. Note that the operative date of this permit is July 2, 2018; before this date, this permit is not available to authorize construction of a footbridge.

Refer to the applicable rule text for all of the specific requirements that must be met for a project to qualify for each general permit-by-certification.

General Permits

General permits (which are described in Section 3.1.3) can authorize the construction or reconstruction of bridges, culverts, or footbridges under general permits 9, 10, and 12. Refer to the applicable rule text for all of the specific requirements that must be met to obtain each general permit.

General permit 9 (located at N.J.A.C. 7:13-9.9) authorizes the construction or reconstruction of a bridge or culvert over a regulated water that drains less than 50 acres. Because the drainage area is less than 50 acres, hydraulic calculations are not required. Therefore, a replacement bridge or culvert need not be in-kind.

General permit 10 (located at N.J.A.C. 7:13-9.10) is reserved for the reconstruction of bridges or culverts over regulated waters that drain more than 50 acres. General permit 10 cannot be used to construct a new bridge or culvert. An engineering certification (see Section 3.3.1) is required for this general permit to ensure that no additional offsite flooding will occur in any of the 2, 10, 25, 50, 100-year, or flood hazard area design flood events. Note that even if the proposed structure meets each requirement listed at N.J.A.C. 7:13-9.10(a)2, hydraulic calculations may be required as part of the engineering certification, depending on the proximity of nearby structures to the bridge or culvert. Best engineering judgement must be used on a case-by-case basis to determine if calculations are necessary.

General permit 12 (located at N.J.A.C. 7:13-9.12) is reserved for the construction of a footbridge. If the design criteria listed at N.J.A.C. 7:13-9.12 are followed, a hydraulic analysis demonstrating that no additional offsite flooding will occur is not required for either the 2, 10, 25, 50, 100-year, or flood hazard area flood events. If the design criteria cannot be met, the project does not qualify for general permit 12.

10.2 Hydraulic Standards

N.J.A.C. 7:13-12.7 establishes limits on the amount of additional flooding that may be associated with the construction or reconstruction of a bridge or a culvert.

Under N.J.A.C. 7:13-12.7(d)1, a new structure may only increase offsite water surface elevations by a maximum of 0.2 feet at any point along a regulated water. However, no offsite habitable building, railroad, roadway, or parking area may be subjected to any increased depth or frequency of flooding. In other words, where such offsite structures exist, the 0.2-foot increase in water surface elevation is not allowed. No increase in water surface elevation is allowed in these areas. Note that an increase in water surface elevation of up to 0.04 feet is considered equivalent to no increase since N.J.A.C. 7:13-12.7(b)1 requires that all calculations be rounded to the nearest 0.1 foot.

The hydraulic standards for reconstructed bridges and culverts differ somewhat from those for newly constructed bridges and culvert. For a reconstructed bridge or culvert, the allowed increases in water surface elevation are listed at N.J.A.C. 7:13-12.7(e). As is the case for new construction, a replacement structure may not result in an increase in water surface elevation where offsite habitable buildings, railroads, roadways, or parking areas exist. Otherwise, a 0.2-foot increase is allowed but only within 500 feet of the reconstructed bridge or culvert in either the upstream or downstream direction. Beyond 500 feet, no increase in water surface elevation is allowed.

An additional hydraulic standard applies where terrestrial wildlife crossings are proposed to address a documented issue of fragmentation of terrestrial threatened or endangered species and species of special concern habitat (see Section 10.5 for information on fragmentation and wildlife passages). In these cases, under N.J.A.C. 7:13-12.7(e)1ii, the maximum increase in water surface elevation allowed within 500 feet of the proposed bridge or culvert is one foot. Beyond 500 feet, no increase in water surface elevation is allowed. Also, where offsite habitable buildings, railroads, roadways, or parking areas exist, no increase in water surface elevation is allowed, even if the proposed bridge or culvert design is meant to address a documented fragmentation issue and even if the impact is within 500 feet of the proposed bridge or culvert.

The hydraulic standards of N.J.A.C. 7:13-12.7 apply to the 2, 10, 25, 50, 100-year, and flood hazard area design floods. If these standards cannot be met, the proposed bridge or culvert would result in an adverse impact, as defined at N.J.A.C. 7:13-12.1(g), due to an increased water surface elevation beyond applicable limits. Should a proposed design result in such an adverse impact, the applicant must enter into a contract to purchase all adversely impacted properties, obtain easements encompassing the entire area that will be adversely impacted, or obtain written, notarized permission from the owners of the adversely impacted property. The permission letter must acknowledge the nature and purpose of the proposed project, the depth of additional flooding expected as a result of the proposed project, and the frequency at which the additional flooding is expected. Alternatively, if the applicant is a public entity, the applicant may appropriate any and all adversely impacted properties via eminent domain.

For the purposes of N.J.A.C. 7:13-12.7, when referring to rights-of-way, the term *offsite* typically means outside of the right-of-way. However, private roadways, such as driveways, must connect to public roadways, and in so doing, they encroach into the right-of-way. While the private roadway may be located within a right-of-way, it is still considered an offsite structure. Therefore, an applicant constructing or reconstructing a bridge or culvert carrying a public road may not increase water surface elevations in the right-of-way at any point where private roadways exist within that right-of-way.

10.3 Hydraulic Analyses

All bridges and culverts that require an individual permit under the FHACA Rules must meet the standards of N.J.A.C. 7:13-12.7. Two types of hydraulic analyses can be performed to demonstrate compliance with these standards – a qualitative analysis or a quantitative analysis.

A quantitative analysis will be required in most cases. As per N.J.A.C. 7:13-12.7(d)2 and N.J.A.C. 7:13-12.7(e)2, acceptable quantitative hydraulic analyses for bridges and culverts include:

A Standard Step Backwater Analysis	**A Hydrologic Routing**	**An Inlet/Outlet Control Analysis**

The standard step backwater analysis is explained in Section 10.3.1 with enhancements to this standard analysis explained in Section 10.3.2. Hydrologic routings and the inlet/outlet control analysis are discussed in Section 10.3.3. Backwater considerations will be important for a bridge or culvert located along a fluvial watercourse within the backwater of a larger watercourse, and these are explained in Section 10.3.4. Section 10.3.5 provides the submission requirements for reporting hydraulic calculations for bridges and culverts to the Department.

In limited circumstances, hydraulic calculations may not be necessary, and a qualitative analysis can be performed instead. These primarily include cases where the contributory drainage area of the regulated water is less than 50 acres because regulated flood hazard areas and impacts to water surface elevations do not apply along waters with drainage areas below this threshold value.

Calculations are also not required for in-kind replacements of bridges and culverts because the term *in-kind*, as specified at N.J.A.C. 7:13-1.2, means that there are no hydraulic modifications associated with the proposed structure as compared to the existing structure. Where no hydraulic modifications are made, calculations are not necessary.

Other cases when a hydraulic analysis may not be required are those where qualitative engineering judgement is sufficient to ascertain that there will be no increase in water surface elevation offsite. For example, a new bridge project where the applicant owns property upstream of the proposed bridge on each side of the regulated water will not result in an increase in water surface elevation offsite if both of the following also apply to the site:

- The flood hazard area on either side of the regulated water is contained entirely onsite.
- The site and channel have steep topography upstream of the bridge, such that the lowest elevation of the site at the upstream property limit is at least three feet higher than the road that the proposed bridge will carry.

Based on the Approximation Method (see Section 4.4.3), the greatest hydraulic impact of a bridge is three feet higher than the travel surface of a road. Therefore, if the flood hazard area of a regulated water is contained entirely on an applicant's property (regardless of whether the limits of that flood hazard are known from published mapping or from the Approximation Method) and the proposed bridge was positioned at least three feet below the lowest topographic upstream elevation onsite, any increases in water surface elevation would necessarily have to be contained onsite as there would be too much topographic relief for the proposed bridge or culvert to have an effect on offsite water surface elevations. As a result, hydraulic calculations would not be necessary.

When proposing to use a qualitative argument, the rationale for why calculations are not necessary must be included in any application to the Department. Should the Department agree with the rationale, no calculations will be required. Otherwise, a qualitative analysis, such as the standard step backwater analysis, will be necessary.

10.3.1 Standard Step Backwater Analysis

The most commonly utilized program for standard step backwater analysis is HEC-RAS. Refer to Section 4.6.3 of this manual for guidance concerning how to prepare a HEC-RAS analysis for Department review. Also refer to the *HEC-RAS User's Manual* and the *HEC-RAS Hydraulic Reference Manual* for more technical information. These two documents can be downloaded from http://www.hec.usace.army.mil/software/hec-ras.

Note that many bridges and culverts cross regulated waters with older Department delineations. These delineations are primarily based on HEC-2, which is a forerunner of HEC-RAS. HEC-RAS provides a more updated and accurate methodology for computing water surface elevations with respect to bridges and culverts. Therefore, the Department recommends that where older HEC-2 analyses exist, the applicant first convert that HEC-2 model to HEC-RAS and update the bridge/culvert data. The updated HEC-RAS model would then serve as the existing condition against which the hydraulic impact of the proposed bridge or culvert would be evaluated.

Specific considerations must be taken into account when modeling bridges and culverts, which are in addition to those considerations that apply to analyses that do not contain such structures. Several input parameters have special significance when modeling a bridge or culvert in HEC-RAS, including the following, which are all discussed further below:

- Cross-section location and extent
- Expansion/contraction coefficients
- Ineffective flow areas
- Guiderails and parapet walls

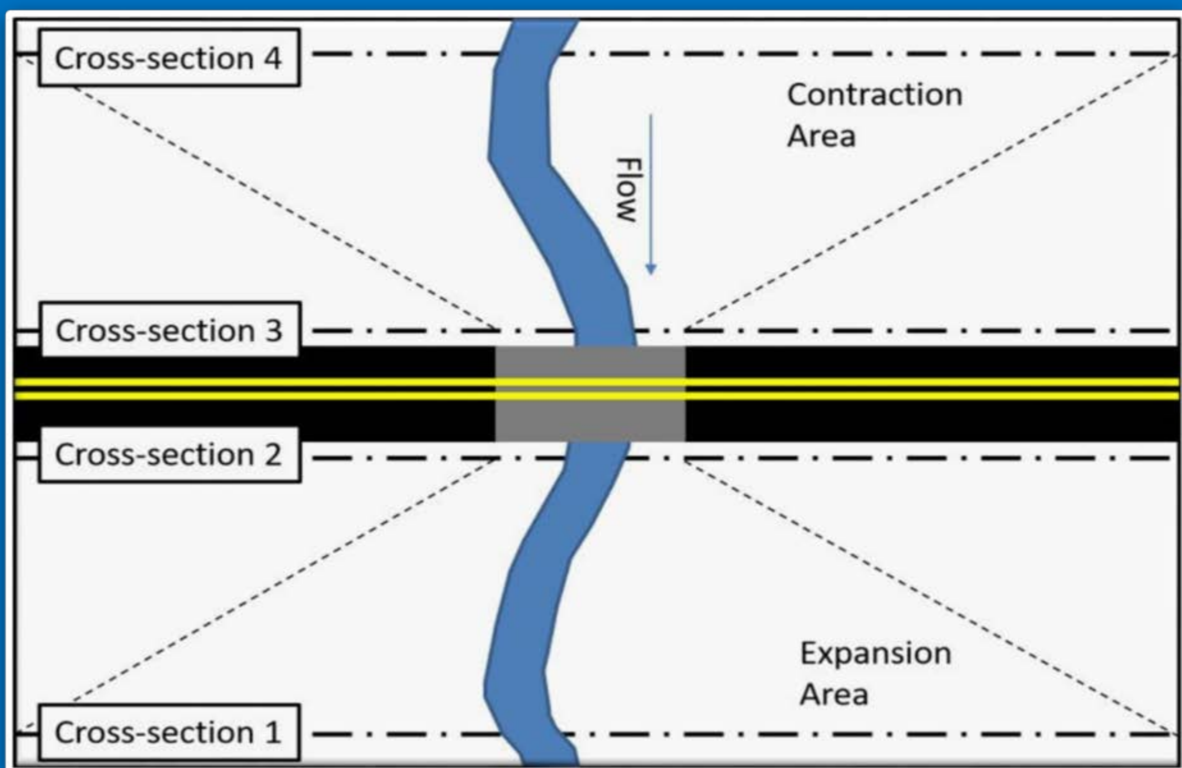
Cross-Section Location and Extent

Typically, four cross-sections define a bridge or culvert, referred to as cross-sections 1 through 4. Cross-sections 1 and 2 are located downstream of the structure while cross-sections 3 and 4 are located upstream. These cross-sections are meant to describe the available flow area near the structure as well as to allow an analysis of the impacts of flow as it contracts to enter the structure and expands to exit the structure.

Refer to the most current version of the *HEC-RAS Hydraulic Reference Manual* for guidance concerning the location of each of these cross-sections. The HEC-RAS manual explains that cross-section 1 should be located at a point far enough downstream where the flow has fully expanded. Similarly, cross-section 4 should be located at a point upstream of the structure where flow has not yet contracted. These locations can be estimated based on the size of the opening and the amount of flow expected to pass through the opening. Often, the optimal location of cross-sections 1 and 4 are estimated, based on the estimated width of the flood plain, so best engineering judgement needs to be used in conjunction with the guidance offered in the *HEC-RAS Hydraulic Reference Manual*.

Typically, cross-section 2 is located in close proximity to the structure, just beyond any roadway embankments. Cross-section 3 is similarly located on the upstream side of the structure. Figure 10.1 below demonstrates the location of all four cross-sections.

Figure 10.1: Placement of Cross-Sections Near a Bridge or Culvert



In addition to their relative location, the extent of the cross-sections for an analysis must also be considered. While the Department recommends that a typical standard step backwater analysis extend at least 500 feet upstream and downstream of a project site, different limits may be required to capture the full extent of the hydraulic impact associated with any proposed bridge or culvert. Study limits should always extend offsite, which for a project involving only a bridge/culvert (as opposed to a verification of a flood hazard area along a site containing a bridge or culvert), should be at least 500 feet upstream and downstream of the structure as N.J.A.C. 7:13-12.7(e) requires that there be no increases in water surface elevation beyond 500 feet of a bridge/culvert replacement. Extending the study limits to match this distance can definitively demonstrate compliance with this standard.

Often, the starting water surface elevations at the study limits are not known and therefore must be estimated (typically via a normal or critical depth calculation). While the true starting water surface elevations may not necessarily be at normal or critical depth, which would introduce an error in the computed water surface elevations, the severity of the error will diminish as calculations proceed through successive cross-sections leading to the bridge or culvert. Therefore, extending the analysis offsite will afford the opportunity for a more accurate calculation of water surface elevations at the structure.

In certain cases, extending the model further upstream than 500 feet will be necessary, which will require more survey work. For example, if a bridge or culvert that is more hydraulically efficient is proposed to replace a less efficient structure, the water surface elevation will decrease and stored volume upstream of the structure will be lost. If the existing and proposed water surface elevations do not converge for a given flood event at the upstream study limit (typically 500 feet), the amount of storage volume lost during a particular flood event cannot be accurately determined. Therefore, additional cross-sections need to be obtained further upstream so an applicant can adequately demonstrate that the lost volume will not result in increased water surface elevations downstream of the proposed structure. Without such a demonstration, a flood hazard area permit or authorization cannot be granted.

Similarly, in certain cases, extending the model further downstream than 500 feet will be necessary. For example, when another structure is located more than 500 feet downstream from the proposed structure and it causes a backwater significant enough to impact the hydraulics near the proposed structure, the hydraulic analysis needs to extend further than the typical 500-foot length downstream to this structure.

Expansion/Contraction Coefficients

When utilizing HEC-RAS for a hydraulic analysis for a bridge or culvert, the modeler should pay careful attention to energy losses due to expansion and contraction. Typically, the contraction and expansion coefficients associated with a bridge or culvert are higher than those associated within the natural channel reach due to the greater degree of upstream contraction and downstream expansion that flow experiences while traversing a bridge or culvert. To capture such losses, higher contraction and expansion coefficients should be input at cross-sections 1 through 4 than in other cross-sections where form loss is not as great a consideration. See the discussion of these coefficients in Section 4.6.3 for additional information.

Ineffective Flow Areas

The presence of a bridge or culvert across a regulated water can affect water surface elevations and velocities in the channel. Because of upstream contraction, the entirety of cross-section 3 may not be available to convey flow. Similarly, because of downstream expansion, the entirety of cross-section 2 may not be available to convey flow under all flood events. To account for these form losses, ineffective flow areas need to be added to the HEC-RAS model at cross-sections 2 and 3. It is not necessary to specify ineffective flow areas at cross-sections 1 and 4 because they should be placed in areas where there is no contraction or expansion.

Judgement needs to be used when determining the locations and elevations of ineffective flow areas. Refer again to the *HEC-RAS Hydraulic Reference Manual* for guidance. Note that ineffective flow is most relevant during low flow and pressure flow conditions.

Typically, the ineffective flow areas placed along cross-sections 2 and 3 are located slightly beyond the bridge or culvert opening. The upstream elevation for ineffective flow should be specified at the elevation where weir flow begins, which can be at the top of the road or curb (or sometimes at the top of the parapet if it affects the floodplain). The downstream elevation can be more difficult to estimate, but an initial estimation between the low chord and the elevation at which weir flow will occur can be used. After the analysis is run with the initial estimate, output must be examined to ensure it is reasonable. Changes in water surface elevation and velocity at cross-sections 2 and 3 must be compared to determine how to optimize the downstream ineffective flow elevation. For example, if the model shows weir flow at the upstream face of the bridge, the downstream ineffective flow elevations cannot cause a scenario in which there is no weir flow at the downstream face of the bridge. This is an iterative approach.

Guiderails and Parapet Walls

Guiderails and parapets need to be included in some, but not all, hydraulic analyses, depending upon the landscape in which a guiderail or parapet is located as well as the height and width of the floodplain of interest (2-year, 10-year, 25-year, 50-year, 100-year, and flood hazard area). For example, the vertical distance between the weir flow elevation and the bottom of a standard guiderail (by New Jersey Department of Transportation specifications) is usually enough to allow floodwaters to pass through without concern about increasing flood elevations. In such cases, the guiderails generally do not need to be included in a hydraulic model. However, in cases where the opening beneath a guiderail is obstructed by grading along a roadway embankment, the flow area beneath the guiderail may not be available to convey flow. As a result, the guiderail would need to be included in the hydraulic analysis.

Likewise, parapets should be modeled as obstructions whenever their presence will affect the elevation at which weir flow effectively occurs. Otherwise, they do not need to be included in the model.

10.3.2 Enhanced Hydraulic Analyses

Some bridges and culverts require enhancements to the basic standard step backwater analysis, such as the following, all of which are explained below:

Perched Bridges

A *perched bridge* is one whose approach roadways are at the same elevation as surrounding grade, but in the immediate vicinity of the bridge, the road rises above the surrounding ground elevation to cross the regulated water. Where a perched bridge exists, floodwaters flow over the road before overtopping the bridge. For this reason, the Department recommends that high flow events be modeled with the energy equation as opposed to the pressure and weir equations.

Parallel Bridges

Some road crossings may consist of *parallel bridges* in which each bridge is separated from another by a set distance. In some cases, the parallel bridges are close enough together that they can be modeled as a single structure, depending on the ability of flow to expand in between bridges. If there is not enough room for flow to expand out of the upstream crossing, the parallel bridges can be modeled as a singular structure. Otherwise, they need to be modeled as separate structures.

Low Water Bridges

Low water bridges are designed only to convey low flows. Higher flows overtop the bridge. For flood events where most of the flow overtops the bridge, the energy equation can be used to compute water surface elevations. It is not usually necessary to default to the pressure and weir equations.

Skewed Crossings

Not all bridges are constructed perpendicularly to the watercourse. They may cross at an angle. If the bridge angle is skewed too much with respect to the watercourse, the flow capacity of the bridge will be less than it would be if it was not skewed. If this skew is not properly analyzed, computed water surface elevations will be underestimated. The skew angle is measured from a line drawn perpendicular to the HEC-RAS cross-section to a line parallel to the direction of flow through the bridge opening. HEC-RAS has a skew option to analyze the skew angle. Typically, the skew angle becomes a significant factor if its magnitude measures 20 degrees or more.

Sequential Culverts

A culvert crossing can consist of a system of pipes or boxes, one placed directly in front of another. As flow passes through the culvert system, it enters, travels through, and exits one pipe or box only to immediately enter another structure before being discharged to the natural channel. Each segment of the culvert may have a different shape, cross-sectional area, or slope. Each segment may even be made of different materials. A typical HEC-RAS analysis will not be able to correctly analyze such a culvert system because it requires cross-sections 2 and 3, which do not exist in this circumstance.

One solution to this problem is to alter the HEC-RAS model to include the use of the lid option. This methodology is only appropriate for flow rates associated with low flow and pressure flow conditions. It does not work for weir flow. Where weir flow exists, the modeler should instead compute a hydraulically equivalent pipe to serve as a surrogate for the culvert network in the HEC-RAS analysis. If there are both pressure and weir flow conditions, two separate HEC-RAS models must be prepared – the first to deal with low flow and pressure flow conditions and the second to deal with weir flow conditions.

When using lids, the modeler must ensure that the elevation of the lid is placed above the hydraulic grade line. Otherwise, HEC-RAS will assign the area above the lid as flow area, which results in a modeling inaccuracy since no such flow area physically exists. Where an equivalent section is used to model weir flow, the modeler must ensure that there is pressure flow throughout the entire length of the culvert system. For more information, refer to the *HEC-RAS Hydraulic User's Manual*.

A possible alternate solution to the lid method is to model the most hydraulically restrictive portion of the culvert as a surrogate for the entire system. This may not be the most technically accurate methodology, but it will suffice in determining the relative difference in water surface elevations in comparing existing and proposed conditions. Alternatively, the modeler can consider analyzing the culvert system as if it were a storm sewer system and utilize other programs to compute energy losses and water surface elevations. In using this approach, it is important to ensure that the program accounts for all bend losses, structural losses, entrance and exit losses, materials differences, and size differences.

Multiple Openings

Some road crossings contain multiple culverts, bridges, or both to convey floodwaters. In these circumstances, the structures are placed adjacent to one another, not sequentially. To model a crossing with multiple openings, HEC-RAS will assume a flow distribution through each opening and then perform an energy balance. If the computed energy difference between the openings and the upstream cross-section is too high, HEC-RAS will change the flow distribution until either the difference is low enough or until the maximum number of iterations is reached. The modeler must check the results to verify they are reasonable before finalizing the model.

To perform these calculations, flow boundaries, called stagnation points, must be established at each opening. The modeler can establish them, or HEC-RAS can assign them. In most cases, the Department prefers for HEC-RAS to establish these points.

10.3.3 Other Types of Hydraulic Analyses

The FHACA Rules allow other types of analyses in addition to the standard step backwater analysis, including inlet/outlet control calculations and hydrologic routings, each of which are discussed below.

Inlet/Outlet Control Calculations

Inlet control occurs when a culvert barrel can convey more flow than its entrance will allow. It is typically associated with steeper slopes where the backwater elevation is less than the critical depth elevation at the inlet. Under inlet control, critical depth usually occurs at the inlet. Water surface elevations upstream of the inlet are determined by the cross-sectional area of the culvert, the size and shape of the culvert opening, and the presence or absence of wingwalls and headwalls.

In contrast, outlet control occurs when a culvert barrel cannot convey as much flow as the culvert entrance will allow. It commonly occurs in situations where the hydraulic grade line within the culvert is higher than the critical depth elevation or where milder slopes exist, although a high tailwater elevation may negate the relevance of the slope. Under outlet control, water surface elevations at the upstream face of a culvert are determined by the size and shape of the culvert, the roughness of the material constituting the culvert, the length and slope of the culvert, and the tailwater elevation.

Inlet and outlet control calculations must be performed for each flood event specified at N.J.A.C. 7:13-12.1(i) for both the existing and proposed conditions.

Inlet and outlet control calculations can be performed based on methodology published by the Federal Highway Administration in *Hydraulic Design of Highway Culverts*, known as HDS-5, which can be downloaded from www.fhwa.dot.gov/engineering/hydraulics/culverthyd/. A variety of computer programs have the ability to compute water surface elevations by both inlet and outlet control. See Section 4.6.2 of this manual for additional discussion of HDS-5.

Note that inlet and outlet control calculations must be performed for each flood event specified at N.J.A.C. 7:13-12.1(i) for both the existing and proposed conditions as a given culvert can operate under inlet control for certain flood events but under outlet control for others.

Inlet and outlet control computations can be performed as an alternative to a HEC-RAS analysis in the following limited circumstances:

- When an existing crossing is proposed to be replaced
- When the proposed crossing will not be more hydraulically efficient than the existing crossing (i.e., when the proposed crossing will not result in decreases in upstream water surface elevation)
- When the proposed crossing will not result in an increase in upstream water surface elevation

Routings and Downstream Impact Analyses

Both N.J.A.C. 7:13-12.7(d)2 and (e)2 allow hydrologic routings to analyze the impact of a proposed bridge or culvert. This is primarily meant for level pool (Modified Puls) routings. In a level pool routing, the storage behind an existing culvert is computed as the difference between the inflow to and outflow from a bridge or culvert. The inflow to a culvert is calculated separately, and an entire hydrograph (not just a peak flow rate) is needed. Outflow and storage are determined via a mass balance computation given the inflow hydrograph, the storage volume that exists upstream of the culvert, and the geometry of the culvert.

While a routing is conditionally acceptable, the following must be considered before performing a routing:

- A full inflow hydrograph, as opposed to just a peak flow rate, is needed. In cases where only a peak flow rate is known, a hydrograph must be submitted. Because the relative difference in existing and proposed water surface elevations is a critical factor with respect to culvert and bridge construction and reconstruction, the Department recommends discarding the study from which the peak flow rates originated and computing the hydrograph for each flood of interest separately rather than trying to reverse engineer a hydrograph to fit a peak flow rate.

- Backwater needs to be known or reasonably estimated. A backwater condition, if not accounted for, can skew the results of the routing. An overestimated backwater can mask the efficiency of an existing bridge or culvert while an underestimated backwater will make the bridge or culvert appear to be more efficient than it really is. (See Section 10.3.4 for backwater considerations.)

On its own, a routing is usually only appropriate when an existing bridge or culvert acts as a control structure for a specific storm. Otherwise, routings do not help determine compliance with N.J.A.C. 7:13-12.7. Therefore, routings are most commonly used in conjunction with a standard step backwater analysis (steady flow analysis). However, an unsteady flow analysis may also be used so that a separate routing does not have to be performed. Both analyses are described below. Whether to use a steady flow model with a routing or an unsteady flow model should be based upon the modeler's ability to understand and accurately develop and execute the selected method.

Steady Flow Analyses with Routings

When the flow rate in a regulated water is greater than the capacity that a bridge or culvert can convey, water starts to pond on the upstream side of the structure. This ponding reduces the peak flow rate that is conveyed downstream of the structure. In effect, the bridge or culvert acts like a detention basin outlet structure in that it will reduce the peak flow rate through it. The degree to which the peak flow rate is reduced is based on the dimensions of the bridge or culvert as well as the amount of available upstream floodplain storage. Therefore, if the bridge or culvert is replaced with a structure that has a greater capacity (typically a larger hydraulic opening and/or a lower effective weir elevation), the amount of upstream detention is reduced. This loss of detention can result in decreases in water surface elevations upstream of the structure and corresponding greater peak flow rates and increases in water surface elevations downstream of the structure.

To account for the downstream impacts, a routing needs to be performed in conjunction with a steady flow analysis for each flood event where increased hydraulic efficiency is a concern. Decreases in upstream water surface elevations are usually an indication that there is a loss of detention that the modeler must consider. If is the loss of detention is significant enough, a routing must be utilized. N.J.A.C. 7:13-12.7 allows no greater than a 0.2-foot increase in water surface elevation within 500 feet of a replacement bridge or culvert, and where structures exist in a floodplain of interest (2, 10, 25, 50, 100-year, or flood hazard area), no increase in water surface elevation is allowed. Therefore, if the modeler cannot qualitatively demonstrate to the Department that any decrease in water surface elevation will not result in downstream increases beyond these thresholds, a routing will be required to demonstrate compliance with N.J.A.C. 7:13-12.7(e)1 for each flood event where an upstream loss in detention is a concern.

A routing should be performed for both the existing and proposed structures so that the hydraulic impact of the proposed structure may be accurately assessed. By itself, a steady flow analysis cannot account for changes in peak flow rate that result from the replacement of a bridge or culvert with a more hydraulically efficient structure. A routing is necessary to account for these changes. Once the routing is completed, the new flow rate must be added to the steady flow analysis at each cross-section downstream of the proposed bridge or culvert to determine if the proposed structure will increase water surface elevations in the downstream direction beyond what is permissible under N.J.A.C. 7:13-12.7(e). Without a routing, a steady flow HEC-RAS analysis will be incomplete in that it will not fully capture the hydraulic impact of the proposed bridge or culvert.

When performing a routing analysis, both the existing and proposed water surface elevation profiles should converge upstream of the location of a proposed bridge or culvert so that the total volume of lost detention can be accurately determined. Otherwise, the resulting increase in peak flow rate in the downstream condition cannot be accurately calculated. Where water surface elevation profiles do not converge, the applicant can either obtain additional surveyed cross-sectional data until such point that the water surface elevation profiles converge for each storm of interest or alter the design of the proposed structure to eliminate the need to obtain additional cross-sections.

Unsteady Flow Analyses

Instead of performing a steady flow HEC-RAS analysis in conjunction with a routing, the applicant can instead make use of an unsteady flow HEC-RAS model, which is a more in-depth analysis but will account for lost detention without the need to perform a separate routing. Developing and running an unsteady flow model will typically require more hydrologic data and a more rigorous modeling effort. Refer to any hydraulic reference book for an in-depth discussion of how to perform unsteady flow analyses.

Model stability is a bigger concern with unsteady flow models. An unstable model (where errors in creating the model result in unrealistic computed water surface elevations) may crash, and a model that crashes will not compute water surface elevations. The following parameters can be sources of model instability that may cause a model to crash:

- **Cross-section spacing**

  Cross-sections must be spaced so that they describe the hydraulic properties of the watercourse without abrupt change. Either overestimating or underestimating the distance between cross-sections can cause enough instability that the model will crash. Even if the model does not crash, the accuracy of the computed elevations may not be acceptable. Generally, additional cross-sections are required (i.e., cross-sections need to be placed closer together) for the following situations:

  - Transition zones where flow is flowing out of the channel into the overbank area or vice versa
  - Vertical slope changes where the flow is going from flat mild slope to steep slope or vice versa
  - Steep river reaches where supercritical flow is possible

- **Computational time step**

A proper time step is critical to running an unsteady flow model. If the time step between calculations is too large, a greater amount of flow attenuation may result. Conversely, if the time step is too small, the model may crash.

- **Manning's n values**

A Manning's n value that is too high can overestimate the attenuation that actually occurs along a watercourse. A value that is too low can result in supercritical flow that may not actually occur.

- **Low flows**

Not only are low flow conditions detrimental to fish but they may also cause an unsteady flow model to crash.

- **Critical depth**

Critical depth usually occurs where changes in cross-sectional area, flow depth, and flow velocity are abrupt. If the unsteady flow model inappropriately indicates critical depth, computed water surface elevations may be inaccurate. Unless the reach of watercourse being analyzed truly operates under supercritical or mixed flow, it may be better to run the model with subcritical flow.

- **Bridges and Culverts**

HEC-RAS pre-processes information at bridges and culverts into rating tables. If there is not enough data in these tables, HEC-RAS will extrapolate water surface elevations, which might not necessarily be consistent with the channel geometry upstream and downstream of the bridge or culvert, possibly leading to inaccurately computed water surface elevations.

- **Ineffective flow**

Ineffective flow areas with large storage areas behind them can also result in model instability. At one elevation, the flow is ineffective, but it will be effective at a slightly higher elevation. This causes an abrupt change in conveyance, which can lead to instability.

Additional considerations apply to unsteady flow models. Because of the complex nature of the unsteady state flow equations, HEC-RAS does not explicitly solve for water surface elevations.

Therefore, while having a stable model is important, a stable model does not necessarily mean that the computed water surface elevations are accurate. Unsteady flow models must be built carefully.

10.3.4 Backwater Considerations

Special considerations may also be necessary for a bridge or culvert located along a fluvial watercourse within the backwater of a larger watercourse. These considerations depend on whether the parent watercourse is fluvial or tidal. Both fluvial backwater analyses and tidal backwater analyses are discussed below.

Fluvial Backwater

In instances where the existing or proposed bridge or culvert is along a watercourse that is influenced by the backwater of a larger fluvial watercourse, the impacts of the bridge or culvert may need to be analyzed using multiple starting water surface elevations (assuming the watercourse has a subcritical flow regime) for each analyzed storm event. An incorrect starting water surface elevation can invalidate the results of the analysis to the point that relative differences between existing and proposed water surface elevations cannot be determined.

For example, a flood along a smaller watercourse containing a bridge or culvert to be constructed or reconstructed may peak well before the flood of the same frequency peaks along a larger watercourse. If the peak backwater elevation overtops the bridge or culvert in question and if that backwater elevation is used as the starting water surface elevation in the hydraulic analysis, the backwater will mask the impact of the proposed structure because the hydraulic impact of the structure along the smaller watercourse would most likely occur when the backwater from the larger watercourse is at a lower elevation or when there is no backwater. Therefore, it is better to use a lower starting water surface elevation, such as normal depth. The correct starting water surface elevation ultimately depends upon the degree of hydraulic influence of the larger watercourse on the smaller watercourse.

However, backwater does not need to overtop a proposed structure along a smaller watercourse to mask the hydraulic impact of that structure. Backwater at lower elevations can also mask the hydraulic impact of a proposed structure. In these cases, the backwater elevation from the larger watercourse should be determined when the smaller watercourse experiences its peak flood for each flood event specified in N.J.A.C. 7:13-12.1(i). Unfortunately, such elevations are not typically known. Therefore, it may be prudent to conduct the analysis with a variety of starting water surface elevations. Where backwater is not an issue, a normal depth or critical depth calculation can suffice, but where it is suspected that backwater will impact the results, other starting water surface elevations must also be considered.

Where it is likely that both the larger and smaller watercourses have similar times to reach peak floods, using the known peak flood elevation of the larger watercourse will not mask the impact of the proposed bridge or culvert. Therefore, using the known peak flood elevation as the starting water surface elevation in the hydraulic analysis is appropriate. However, because the relative timing of flood events is generally unknown, the Department may require multiple analyses with different starting water surface elevations be performed in lieu of determining the proper backwater elevation.

Tidal Backwater

A proposed bridge or culvert will often be located on a fluvial tributary to a parent watercourse or waterbody whose flood is tidally controlled by the Atlantic Ocean. However, should this tributary have a drainage area of at least 50 acres, it will have a fluvial flood hazard area of its own. The tributary must be analyzed to ensure that a proposed bridge or culvert does not increase offsite flooding during fluvial flood events. Unless the fluvial flood peaked at the same time as the tidal flood, using known tidal flood elevations resulting from a specific flood event may mask the hydraulic impact of the proposed structure along the tributary, much in the same way that a fluvial backwater can, as discussed above. Because fluvial flood events can occur during both high and low tides, the range of typical starting water surface elevations to consider include normal or critical depth, the mean high water elevation, and the mean low water elevation.

10.3.5 Submission Guidelines

Section 4.6 of this manual explains the general requirements for a hydraulic analysis while Section 4.8.2 establishes submission guidelines for these analyses. However, additional requirements for engineering drawings apply to applications for the construction, reconstruction, or removal of bridges or culverts.

As for any hydraulic analysis, field surveyed cross-sections must be submitted on signed and sealed engineering drawings with a title block and a true scale. A cross-section location plan showing topography, extent, and orientation of each cross-section is also required. However, for bridges and culverts, the following additional drawings are required:

- ≈ Watercourse cross-sections
    - o In addition to the standard cross-sections, cross-sections of the watercourse describing the proposed bridge or culvert must show the proposed structure at each of the upstream and downstream faces.

- ≈ General plan and elevation
    - o These drawings need to show dimensions of both the existing and proposed structures, including the length of the existing and proposed bridge(s) or culvert(s), the presence of any headwall or wingwalls, the orientation of any wingwalls, the number of spans, width of each span, low chord elevation(s), high chord elevation(s), the dimensions of any parapets, and watercourse invert elevations.

- ≈ Road profile (existing and proposed conditions)
  - o Overlaying the proposed condition on top of the existing condition is easiest, provided lines of different weight are used to distinguish each condition. The profiles must be at a legible scale to provide clarity for the extent of the proposed construction.
- ≈ Road cross-sections (existing and proposed conditions)
  - o Similar to the road profile, overlaying proposed cross-sections on top of existing cross-sections is generally easiest, provided that lines of different weight are used for each condition, a true scale is used, and the information is legible.
- ≈ Routing information
  - o Where a level pool routing is proposed, engineering drawings must depict the entirety of the storage area upstream of each bridge or culvert to be routed. Topography must be included in the depiction of the storage area to verify the information used in the engineering report.

Additional requirements are also necessary in the engineering report for bridges and culverts. For the general information required for a standard hydraulic analysis (HEC-RAS), please refer to Section 4.6.3 and Section 4.8.2. However, the following also apply to projects that involve bridges or culverts:

- ≈ HEC-RAS report
  - o Both an existing and proposed analysis must be submitted. A standard profile summary table should be submitted that is formatted to show the differences between the existing and proposed water surface elevation at each cross-section for each flood event analyzed.
  - o An electronic copy of the hydraulic computations is recommended. As part of an effort to streamline the permitting process, electronic copies of hydraulic calculations enable the Department to conduct sensitivity analyses to determine if revisions are necessary before compliance with N.J.A.C. 7:13 can be determined.
- ≈ Level pool routing information
  - o For any type of level pool analysis, the same type of hydrologic data specified in Section 4.8.1 must be submitted, including drainage area maps showing topography and the limits of each drainage area analyzed as well as derivations of curve numbers and times of concentration. The unit hydrograph must be specified as well as the rainfall distribution and antecedent moisture condition for each flood event analyzed. Specific to the routing, stage-storage-discharge tables must be submitted along with the input

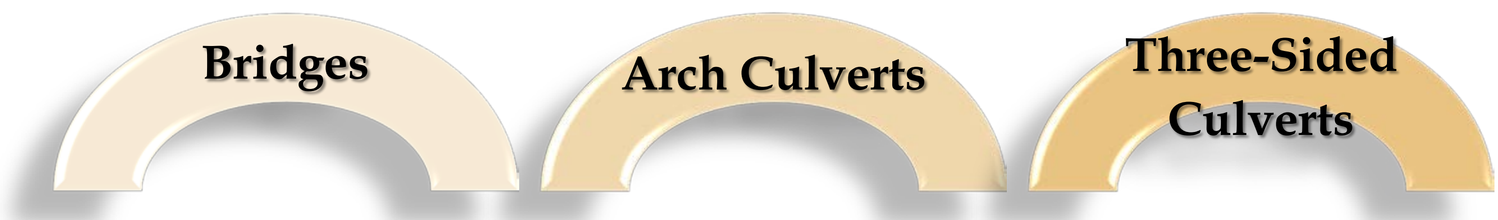
data for the bridge or culvert dimensions (e.g., number and size of bridge or culvert openings, elevation and length of weir) that describe the hydraulic control that the structure represents. Input and output hydrographs need to be submitted for each flood event routed.

10.4 Aquatic Resource Protection Standards

The protection of aquatic resources is one of the principal objectives of N.J.A.C. 7:13. As such, requirements meant for the protection of aquatic resources are contained throughout the FHACA Rules. These requirements include standards for both the types of bridges and culverts that may be constructed (see Section 10.4.1) and the manner of construction (see Section 10.4.2).

10.4.1 Types of Bridges and Culverts

Under N.J.A.C. 7:13-12.7(f), the FHACA rules establish a preference for the following types of bridge/culvert structures:



Any project involving the construction or reconstruction of a bridge or culvert must consider these types of structures before considering circular culverts, elliptical culverts, or box culverts.

The FHACA Rules preference three-sided structures over four-sided structures or pipes (even if the four-sided structures or pipes are buried or provide other artificial means to accommodate aquatic passage in low-flow conditions) because three-sided structures have natural bottoms. One goal of the FHACA Rules is "to protect the wildlife and vegetation that exist within and depend upon [flood hazard] areas for sustenance and habitat," which is facilitated by structures with natural bottoms.

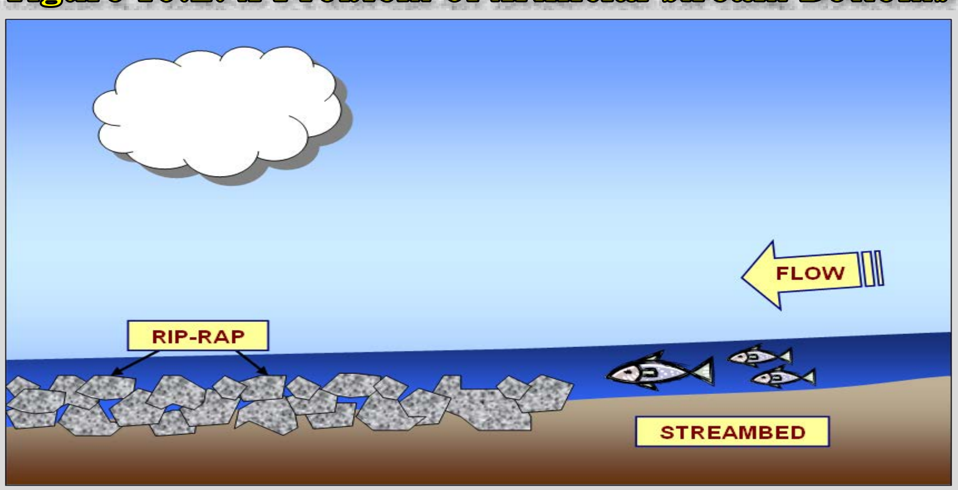
The Federal Highway Administration discusses the importance of fish and aquatic passage in Hydraulic Engineering Circular 26, *Culvert Design for Aquatic Organism Passage*, which concludes that aquatic biota are exposed to the same forces of stream flow as the streambed when it passes through a culvert. Therefore, a culvert should be designed so the flow passing through will have the same effect on the culvert as it does on the natural channel found upstream and downstream of the culvert to avoid adverse impacts to fish or other aquatic biota. The Department has found that providing a natural bottom through bridges and culverts helps accomplish this goal by replicating a natural condition through the structure and representing the most minimal barrier to aquatic passage.

The FHACA Rules limit barriers to aquatic passage to ensure the protection of aquatic ecosystems. Typical barriers include flow velocity through the structure, the presence of weirs and baffles in the structure, turbulence caused at the entrance to the structure, and low-flow conditions through the structure. The Department is particularly concerned with low-flow conditions through a culvert. The term *low-flow aquatic passage* describes the ability of aquatic species to travel up and down a watercourse without impediment during low-flow conditions. During dry periods of the year, water typically collects in small rivulets in the stream bed, permitting aquatic species to migrate upstream and downstream in search of food or for spawning. Structures that eliminate this passage form a barrier to aquatic species, causing them to be trapped on one side of the structure until flow in the watercourse increases.

During low-flow conditions, there may be insufficient water depth for aquatic organisms to pass through a culvert. The Department has noted that certain culverts lack a low-flow channel, which results in the dispersion of lower flows to the point where the water traveling through the culvert is too shallow to allow aquatic organisms to pass. When this occurs, habitat is fragmented, meaning the upstream habitat is cut off from the downstream habitat. Aquatic organisms may also not have enough room to physically maneuver around any baffles or weirs that may be part of a culvert during low-flow conditions. As a result, they risk bodily harm while attempting to traverse the culvert.

Certain culverts are constructed with riprap beds, which the Department has also noted is problematic for low-flow aquatic passage. Clean rip-rap contains many void areas between the stones that will fill with water, as illustrated by Figure 10.2. Since water that normally flows on top of the stream bed will flow through the voids in the rip-rap, the rip-rap can become an impediment to low-flow aquatic passage. For these reasons, bridges and culverts with natural bottoms are preferred.

Figure 10.2: A Problem of Artificial Stream Bottoms



One possible solution to the problem of low-flow aquatic passage is to incorporate an engineered low-flow channel within a culvert. However, since channel thalwegs (the low-flow portion of the channel) are known to meander within the channel, a natural channel thalweg may not always match the location of an engineered low-flow channel in low flow events, which will fragment habitat.

An engineered bottom may be covered by natural substrate as part of an effort to mimic a natural bottom. While this is beneficial, the Department has found that in many cases, natural substrate cannot be used in connection with box culverts or pipes because of erosive velocities associated with flow through these structures. In these cases, the natural stream bottom cannot be faithfully replicated.

To further promote natural bottoms, N.J.A.C. 7:13-12.7(f) specifies that any new or replacement bridges or culverts completely span the channel where possible to preserve the size and shape of the natural channel through the structure. Such preservation will avoid and/or correct less than ideal impacts to aquatic passage. *Culvert Design for Aquatic Organism Passage* notes that fish may reach a point of muscular exhaustion prior to completing a journey through a longer culvert. However, if the culvert spans the channel and maintains the natural channel characteristics throughout its length, fish can rest in the inherent lower velocity zones that exist within the natural channel cross-section until they regain enough strength to traverse the remainder of the culvert.

The Department acknowledges that it is not always possible to construct a three-sided structure with a natural bottom or to span the channel. As a result, N.J.A.C. 7:13-12.7(g) outlines criteria where the construction of other types of structures may be permitted, which are as follows:

- The regulated water does not possess a discernible channel.
- The channel does not contain fishery resources.
- The channel is manmade (waters that historically possessed a naturally-occurring, discernible channel that has been modified by humans are not included in the definition of manmade, as explained in Section 2.1.2).
- The channel is fully lined with manmade impervious material, such as cement or concrete.
- The channel is less than 10 feet wide as measured between the top of bank of each side of the channel.
- Spanning the channel with a bridge, arch culvert, or three-sided culvert is not practicable due to unstable substrate that would likely undermine any proposed footing within or adjacent to the channel, irregular channel configuration, anticipated adverse hydraulic impact to the channel, and/or anticipated adverse impacts to offsite flooding, the environment, or public safety.

In such cases, circular, elliptical, or box culverts can be authorized, provided the justification required by N.J.A.C. 7:13-12.7(g) and (h) is provided. These structures are required to be installed at least two feet below the channel invert and backfilled with native substrate where feasible. If this is not feasible, the rip-rap should be carefully imbedded in the streambed substrate so that the top of the rip-rap is flush with the preconstruction streambed, and the void areas between the stones should be filled with native soil from the stream so that water flows above the entire rip-rap area rather than between the stones.

10.4.2 Construction Standards

In addition to the type of bridge or culvert, consideration must be given to how the structure is to be constructed for the protection of aquatic resources. With respect to methods of construction, the following are areas of concern (each of which is described further below):

- Raw concrete
- Preservation of habitat
- Sedimentation

Raw Concrete

Certain structures require the use of raw concrete onsite. Raw concrete can be toxic to aquatic biota as it can alter the pH of the water. Many aquatic species require water of a certain pH to survive, and changes in pH can also alter the behavior of other chemicals in the water that may affect aquatic species. To prevent these adverse impacts, under N.J.A.C. 7:13-6.7(b), which contains conditions for all permits-by-rule, general permits-by-certification, and general permits as described in Section 3.4, and N.J.A.C. 7:13-11.1(b)3, which contains the standards for activities in a channel authorized under an individual permit, no activity authorized under the FHACA Rules can expose unset or raw cement to flowing water within any channel or regulated water during construction.

Preservation of Habitat

Aquatic habitat should be preserved wherever possible during construction to minimize adverse environmental impacts. As stated at N.J.A.C. 7:13-11.5(c)2, one way to preserve aquatic habitat is to avoid removing logs or boulders that exist within the channel. Should it be necessary to remove these logs or boulder, the Department's approval is required, and the necessity of removal will be determined on a case-by-case basis. A permit will not be issued if any logs or boulders that provide fish habitat are removed from the channel unless the Department has determined it is necessary.

When preservation of aquatic habitat is not possible, the Department recommends that aquatic habitat be enhanced, such as through the placement of habitat enhancement devices, the replacement of vegetation removed during construction, the creation of tree canopy along the channel where no canopy exists, and/or the enhancement of the existing tree canopy.

Sedimentation

Construction activities associated with bridges and culverts can introduce sediment into the water, which can adversely impact aquatic species. For this reason, N.J.A.C. 7:13-11.5 includes timing restrictions where fishery resources may be impacted. A list of waters that contain fishery resources has been provided in the Department's Surface Water Quality Standards at N.J.A.C. 7:9B. This list is supplemented by the following reports:

1. "Classification of New Jersey Waters as Related to Their Suitability for Trout"

2. "List of Waters Stocked with Trout by the New Jersey Division of Fish and Wildlife"

3. "Locations of Anadromous American Shad and River Herring During Their Spawning Period in New Jersey's Freshwaters Including Known Migratory Impediments and Fish Ladders"

Specific timing restrictions are located in Table 11.5 of N.J.A.C. 7:13-11.5, which is reprinted below. Timing restrictions apply to any construction, grading, excavation, or filling activities that could introduce sediment into a channel or riparian zone.

Table 11.5

RESTRICTED TIME PERIODS FOR REGULATED WATERS WITH FISHERY RESOURCES

Water and classification	Time period (inclusive) during which activities are prohibited
1. Trout Waters	
All trout production waters except rainbow trout	September 15 through March 15
Rainbow trout production waters	February 1 through April 30
Trout stocked waters Trout maintenance waters All regulated waters located within one mile upstream of a trout stocked or a trout maintenance water	March 15 through June 15
2. Non-Trout Waters	
Regulated waters that support general game fish located north of Interstate 195	May 1 through July 31

Regulated waters that support general game fish located south of Interstate 195	May 1 through June 30
Regulated waters that support pickerel	Ice out through April 30
Regulated waters that support walleye	March 1 through May 30
3. Anadromous Waters	
All unimpeded tidal regulated waters open to the Atlantic Ocean or any coastal bay All regulated waters identified as anadromous migratory pathways	April 1 through June 30
Delaware River upstream of U.S. Route 1	April 1 through June 30 and September 1 through November 30
Delaware River between U.S. Route 1 and Interstate 295 (Delaware Memorial Bridge) Tidal portions of Raccoon Creek, Rancocas Creek, Crosswicks Creek, and Cooper River	March 1 through June 30 and September 1 through November 30
All unimpeded tidal regulated waters open to the Delaware River downstream of Interstate 295 (Delaware Memorial Bridge) Tidal portions of the Maurice River, Cohansey River, and Salem River	March 1 through June 30 and October 1 through November 30

10.5 Wildlife Passages

Animals must be able to move through the landscape to find food, water, shelter, mates, and other resources necessary for their survival. Above-ground, manmade, linear infrastructure, such as roads, railroads, utilities, and canals, create barriers to this movement and jeopardize the long-term viability of populations. This process, known as *fragmentation*, impacts wildlife populations both directly and indirectly. Wildlife-vehicle collisions, resulting from an animal attempting to cross a roadway, creates a significant hazard to the traveling public and a potentially fatal situation for the animal. Indirectly, linear infrastructure can create smaller sub-populations by isolating species from critical resources and reducing or eliminating migration between populations. This loss of meta-population dynamics reduces genetic diversity, leading to lower overall fitness and an increased vulnerability to local extinction.

One solution to help reduce some of the problems caused by fragmentation is to provide permanent structural openings beneath a roadway to allow species to freely cross from one side of the road to the other. Such wildlife passages allow connections or reconnections between suitable habitats otherwise isolated by the road and reduce collisions between vehicles and animals. A successful means of incorporating wildlife passages beneath roadways is to modify the design of bridges and culverts so that a portion of the natural bank of the channel is preserved or restored, allowing terrestrial species to pass through the bridge or culvert on dry land adjacent to the channel. If a bridge or culvert is flowing full, terrestrial species are unlikely to attempt to walk or swim through the water to reach the other side. However, if a portion of dry bank is provided next to the channel within the bridge or culvert, the species is more likely to attempt passing through the structure.

For a flood hazard individual permit, N.J.A.C. 7:13-12.7(d)3 requires the incorporation of these wildlife passages if a new bridge or culvert (and/or the roadway or railroad it serves) will cause habitat fragmentation for any terrestrial threatened or endangered species or any terrestrial species of special concern, i.e., terrestrial corridor species (TCS). The New Jersey Division of Fish and Wildlife's Endangered and Nongame Species Program maintains the lists of endangered species, threatened species, and species of special concern in New Jersey. The current list and term definitions can be found at http://www.njfishandwildlife.com/tandespp.htm. Figure 10.3 below contains a list of the terrestrial threatened and endangered species and terrestrial species of special concern, as referenced at N.J.A.C. 7:13-12.7(d)3.

Figure 10.3: Terrestrial Corridor Species (TCS)

Endangered	Threatened	Special Concern
Timber Rattlesnake	Wood Turtle	Northern Spring Salamander
Bog Turtle	Longtail Salamander	Carpenter Frog
Corn Snake	Northern Pine Snake	Fowler's Toad
Cope's Gray Treefrog	Eastern Mud Salamander	Jefferson Salamander
Queen Snake	Pine Barrens Treefrog	Marbled Salamander
Allegheny Woodrat		Eastern Box Turtle
Eastern Tiger Salamander		Spotted Turtle
Blue-spotted Salamander		Eastern Kingsnake
Bobcat		Northern Copperhead

In addition to the requirement for terrestrial wildlife passages for new bridges and culverts, the FHACA Rules also require the incorporation of wildlife passages for the reconstruction of an existing bridge or culvert where the existing bridge/culvert causes habitat fragmentation of the TCS under N.J.A.C. 7:13-12.7(e). However, the Department recognizes that incorporating wildlife passage into existing bridges or culverts must be balanced with preventing flooding impacts and reducing impacts to the riparian zone. For this reason, under N.J.A.C. 7:13-12.7(e)1ii, the Department allows for an increase in upstream and downstream flood depths of up to one foot to facilitate compliance with N.J.A.C. 7:13-12.7(e)3 when there is no habitable structure, railroad, roadway, or parking area within 500 feet of the crossing. Also, while disturbance to riparian zone vegetation must be minimized under N.J.A.C. 7:13-11.2(b)2 (see Section 6.4.1), the Department is willing to accept additional impacts to the riparian zone with compensatory mitigation for a bridge or culvert meeting N.J.A.C. 7:13-12.7(e).

General permits 9 and 10 (discussed in Section 10.1) require the maintenance or creation of a natural, earthen channel with low-flow aquatic passage to the extent feasible. While wildlife passages are not explicitly required under a general permit, the replacement bridge or culvert cannot cause adverse impacts to aquatic, semi-aquatic, or terrestrial resources. If the current bridge or culvert is providing any wildlife passage, the replacement must provide equal or greater passage to prevent adverse impacts. The Department will not approve a general permit 9 or 10 that decreases permeability to wildlife from current conditions. Also, in certain instances, replacement bridges or culverts may be within a known wildlife crossing "hot-spot" where the Department has documentation of dead-on-road wildlife or a known movement corridor between areas of ecological significance (i.e., upland habitat and breeding habitat bisected by a roadway). In these rare cases, a crossing may be required under a general permit to prevent further adverse impacts to terrestrial species.

When constructing or reconstructing a bridge or culvert, the presence of Terrestrial Corridor Species (TCS) habitat must first be identified, as explained in Section 10.5.1. Once any TCS habitat has been identified, the applicant must determine if a project will cause fragmentation of that habitat, which is discussed in Section 10.5.2. Section 10.5.3 provides guidance on how to create a wildlife passage map that can aid in determining if a project causes habitat fragmentation. The requirements for the construction of wildlife passages are explained in Section 10.5.4, and Section 10.5.5 provides a list of sources for more information on wildlife passages and bridge culvert modifications.

10.5.1 Identifying the Presence of Terrestrial Corridor Species (TCS) Habitat

The Department identifies present or documented habitat using the Landscape Project mapping, which labels habitat areas required to support local populations of wildlife species (for details see the Division of Land Use Regulation's *Freshwater Wetlands Technical Manual*, available at http://www.nj.gov/dep/landuse/download/fw_016.pdf). ArcGIS users can download the Landscape Project mapping and data at http://www.nj.gov/dep/gis/, and non-GIS users can view the maps using the Department's interactive NJ-GeoWeb mapping application at http://www.nj.gov/dep/gis/geowebsplash.htm.

Once the applicant has access to Landscape Project maps, the following steps should be followed to identify the presence of TCS habitat:

STEP 1	Locate the project site on the mapping.
STEP 2	Identify if any Rank 2, 3, 4, or 5 habitat patches occur on either side of the project site. For example, a proposed roadway with Rank 2 habitat to the north and Rank 3 habitat to the south would be considered as bisecting TCS habitat. However, a proposed roadway with Rank 1 habitat to the north and either Rank 1 or unranked habitat to the south would not be considered as

bisecting TCS habitat.

If Rank 2, 3, 4, or 5 habitat does not occur on one or both sides of the project site, as shown in Figure 10.4 below, wildlife passages do not need to be incorporated into the project design, but if Rank 2, 3, 4, or 5 habitat does occur on one or both sides of the road, as shown in Figure 10.5 (also below), the applicant will need to proceed to Step 3.

Figure 10.4: A Project Not Bisecting TCS Habitat

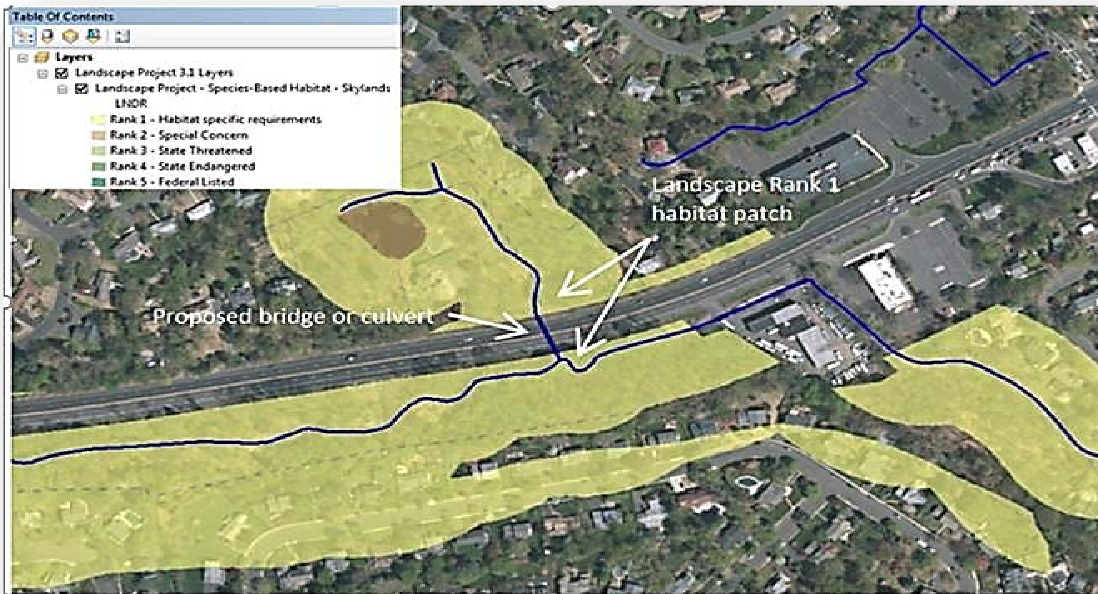
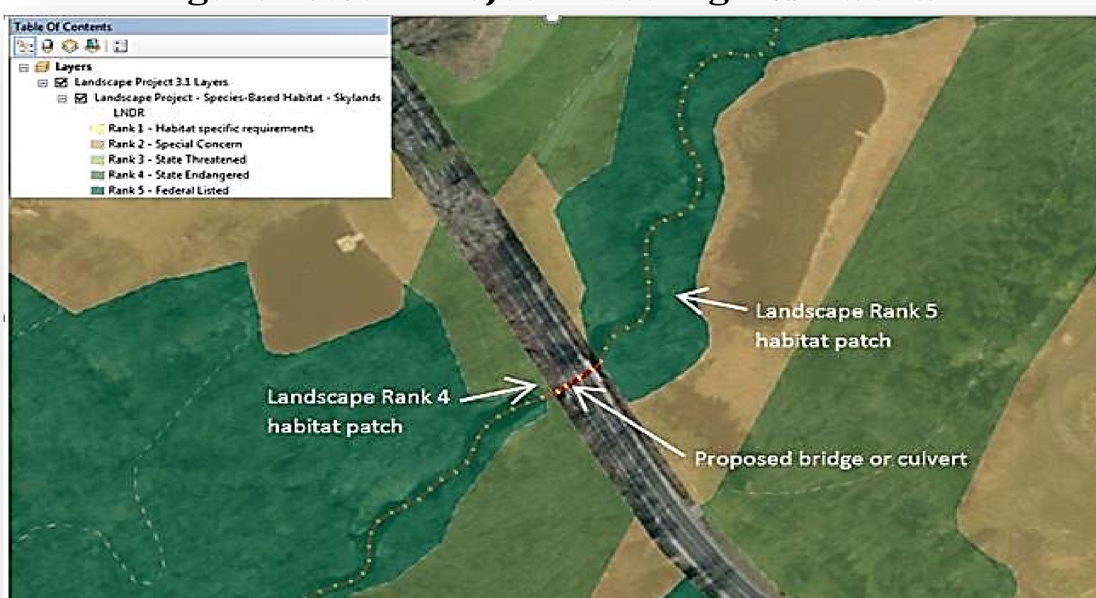


Figure 10.5: A Project Bisecting TCS Habitat



STEP 3

Compare the list of species documented in the Landscape Project mapping with the list of terrestrial corridor species (see Figure 10.3) to identify if any of the TCS occur onsite or adjacent to the project site.

If none of the listed TCS are documented in the habitat patches adjacent to the project, as shown in Figure 10.6 below, the project is not required to incorporate wildlife passages. However, if any of the TCS are documented in habitat patches adjacent to the project site, as shown in Figure 10.7 (also below), wildlife passages may need to be incorporated into the project design if the project is anticipated to cause habitat fragmentation (see Section 10.5.2).

Figure 10.6: No Documented TCS

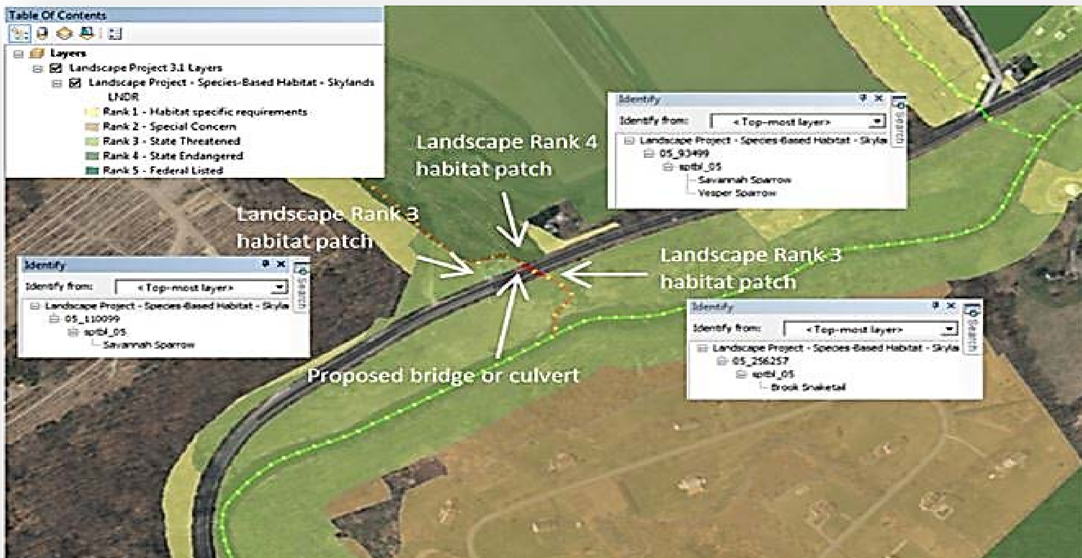
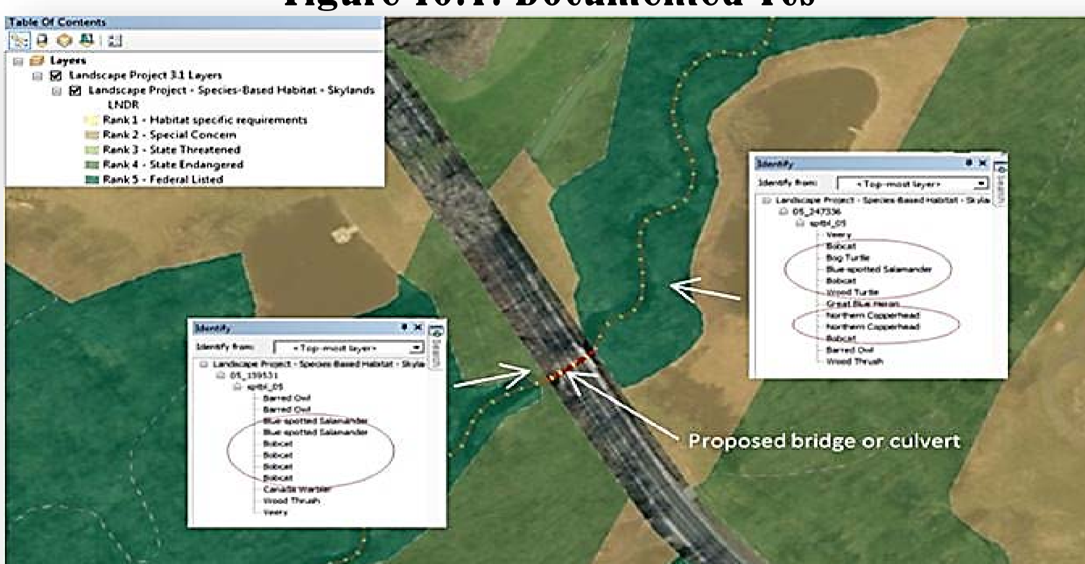


Figure 10.7: Documented TCS



10.5.2 Determining if a Project Will Cause Fragmentation of TCS Habitat

Habitat fragmentation results when a project breaks a contiguous suitable habitat patch or movement corridor. Under N.J.A.C. 7:13-12.7(d)3, a project will be considered to cause fragmentation if it bisects the habitat of terrestrial threatened, endangered, and/or species of special concern. The Department will determine if the incorporation of wildlife passages is necessary on a case-by-case basis to maintain and improve wildlife access along existing viable habitat corridors while providing relief from the standards in situations where wildlife movement is precluded by adjacent development or other unsuitable landscape characteristics.

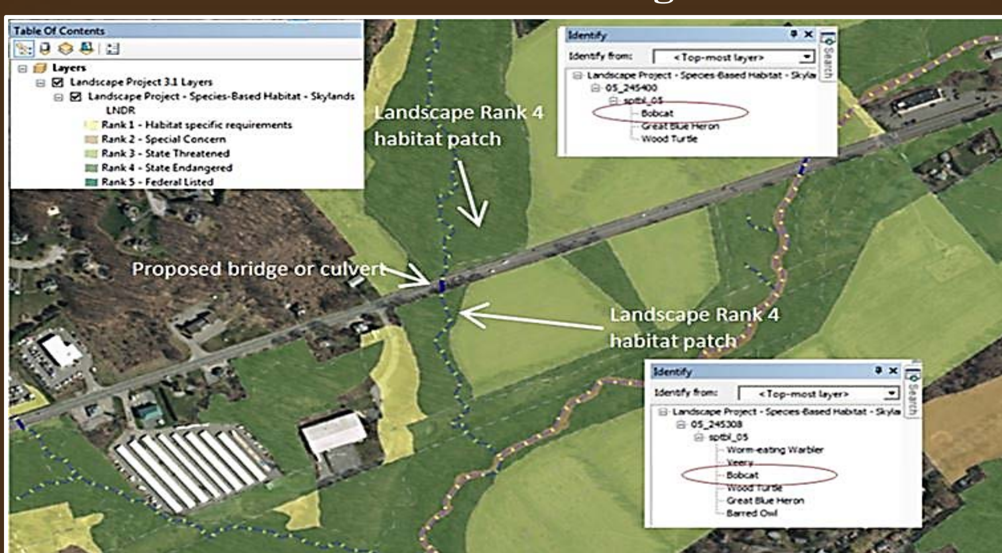
The Department conducts these reviews by comparing the Land Use/Land Cover habitat types with the documented TCS to determine if suitable habitat occurs on both sides of the roadway. The Department also uses aerial imagery and site inspections to determine the effectiveness of installing a wildlife passage at the specific project location. Some examples are provided below. Section 10.5.3 provides step-by-step instructions for creating a wildlife passage map from the Department's Landscape Mapping version 3.3 download. Once created, this layer can aid in determining if a project causes habitat fragmentation.

EXAMPLES:

EXAMPLE 1: Wildlife Passage Required

Figure 10.8 shows an example of a project for which the Department would most likely determine that the inclusion of wildlife passages within the project design is required. Landscape Rank 4 habitat occurs on both sides of a project site that intersects an otherwise contiguous habitat and suitable movement corridor for the TCS in question (bobcat).

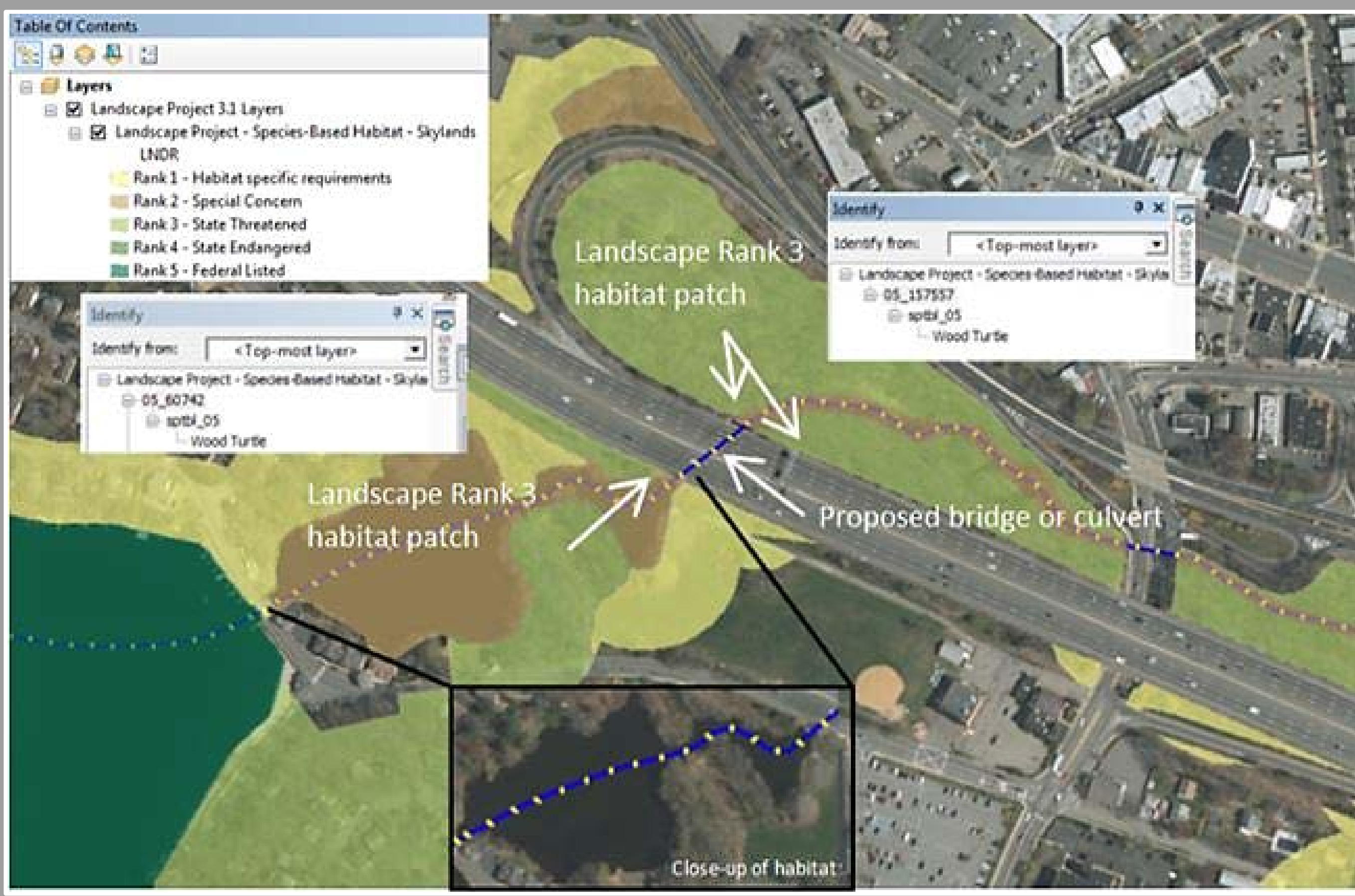
Figure 10.8: Documented TCS on Both Sides of a Road with Suitable Surrounding Habitat



EXAMPLE 2: Wildlife Passage Not Required

Figure 10.9 shows an example of a project for which the Department would most likely determine that the inclusion of wildlife passages within the project design is not required. Despite Landscape Rank 3 habitat on both sides of the project location inclusive of a TCS (wood turtle), the landscape surrounding the applicable stream crossing is not likely to be considered a suitable contiguous habitat or movement corridor for the target species due primarily to the two on-stream impoundments.

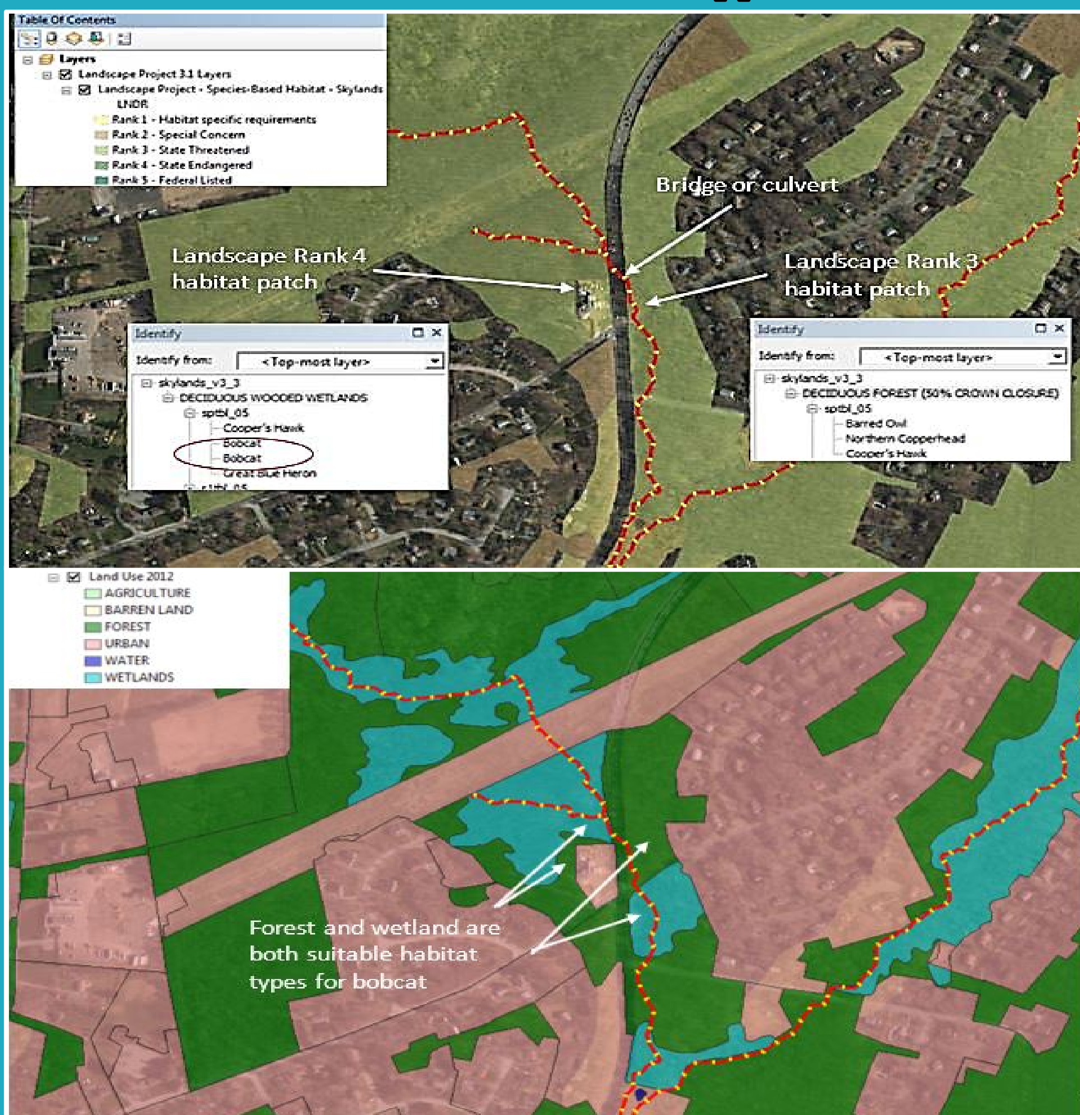
Figure 10.9: Documented TCS on Both Sides of a Road with Unsuitable Surrounding Habitat



EXAMPLE 3: Wildlife Passage Required

Figure 10.10 shows an example of documentation for TCS on just one side of a roadway with suitable habitat on the other side. Bobcat is documented on the western side of Route 206 but not on the eastern side since in Landscape Mapping, Route 206 is considered a major barrier to wildlife and therefore breaks habitat patches. However, the Land Use/Land Cover data shows that suitable habitat for bobcat (wetland and forest) exists on both sides of the roadway, and therefore, a wildlife passage installed in the proposed bridge or culvert would mitigate the habitat fragmentation and allow movement of the species.

Figure 10.10: Documented TCS on Only One Side of a Road with Suitable Habitat on the Opposite Side



10.5.3 Creating a Wildlife Passage Map

For GIS users, the Landscape Project Version 3.3 mapping contains an attribute field in the species table labeled "FHA_TSC" that allows a user to create a statewide or regional map of habitat patches documented for terrestrial species of concern. Such a map can be used to determine the likelihood that a wildlife passage will be required at a particular stream crossing under the FHACA Rules.

Using GIS selection tools, a map of all the habitat patches that are valued by terrestrial species of concern records may be created as follows:

1. Download and add the Landscape Project 3.3 layers to ArcMap (download available at http://www.nj.gov/dep/gis/).

2. In the Table of Contents (TOC), open the attribute table of the region of interest by right clicking the appropriate Region data layer (e.g., piedmont_v3_3), and then choose "Open Attribute Table," as shown in Figure 10.11 at right.

3. Once the table opens, select "Related Tables," and click the species related table (e.g., piedmont_v3_3_species_03:sptbl_03) to open it as shown in Figure 10.12 below.

Figure 10.11: Creating a Wildlife Passage Map – Step 2

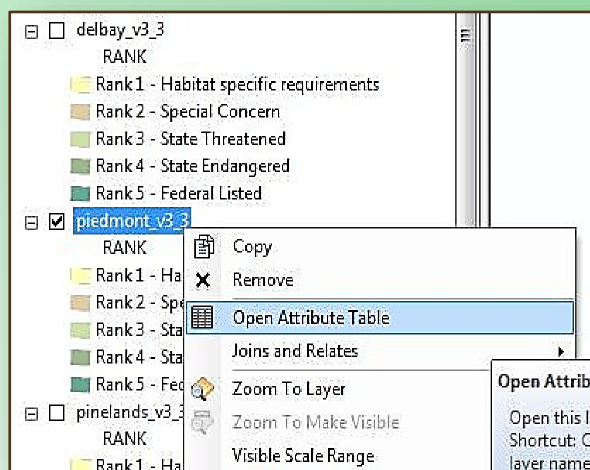


Figure 10.12: Creating a Wildlife Passage Map – Step 3

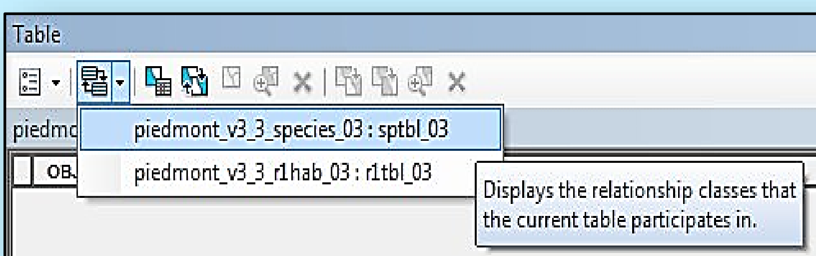
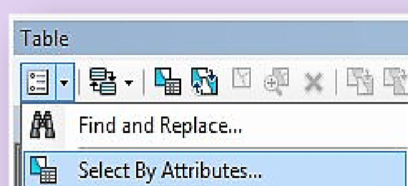
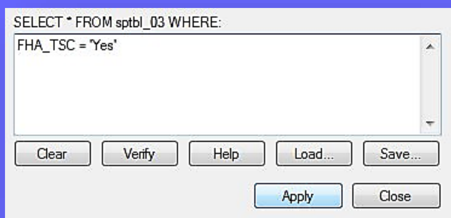


Figure 10.13: Creating a Wildlife Passage Map – Step 4



4. Next, choose "Select by Attributes" from the Table Options menu as shown in Figure 10.13 at right.

Figure 10.14: Creating a Wildlife Passage Map – Step 5



5. In the Select by Attributes menu, type FHA_TSC = 'Yes' in the dialog box and click "Apply" (see Figure 10.14 at left). This command will select each Species of Terrestrial Concern record that values a habitat polygon in the chosen region.

6. To select all valued habitat patches, return to the Region attribute table by clicking "Related Tables" and choosing the habitat table (e.g., piedmont_v3_3_species_03:piedmont_v3_3) from the Related Tables menu. See Figure 10.15 below.

7. In the TOC, right-click the appropriate Region data layer and click on "Selection" followed by "Create Layer From Selected Features" to create a regional terrestrial species map, as shown in Figure 10.16 below. This will create a new layer in the project (e.g., piedmont_v3_3 selection). To export this for future use, right-click the selection layer, and then click "Data>Export Data."

Figure 10.15: Creating a Wildlife Passage Map – Step 6

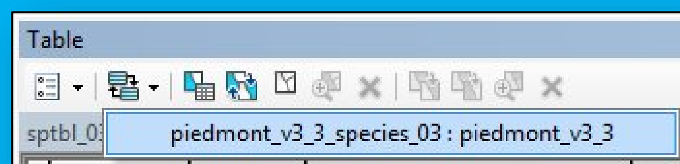
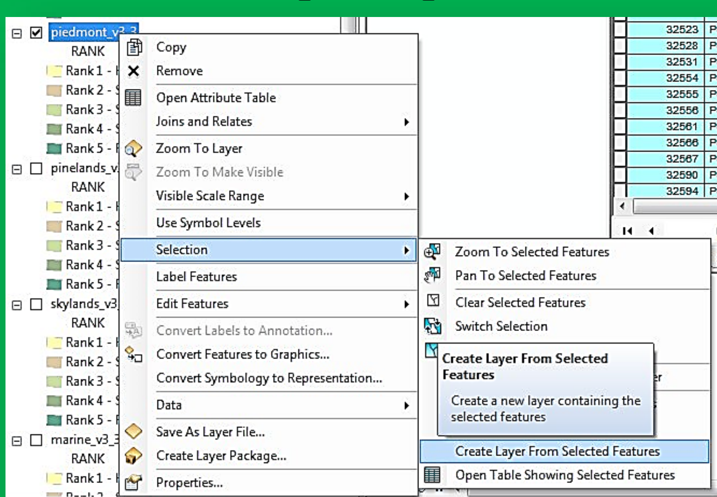


Figure 10.16: Creating a Wildlife Passage Map – Step 7

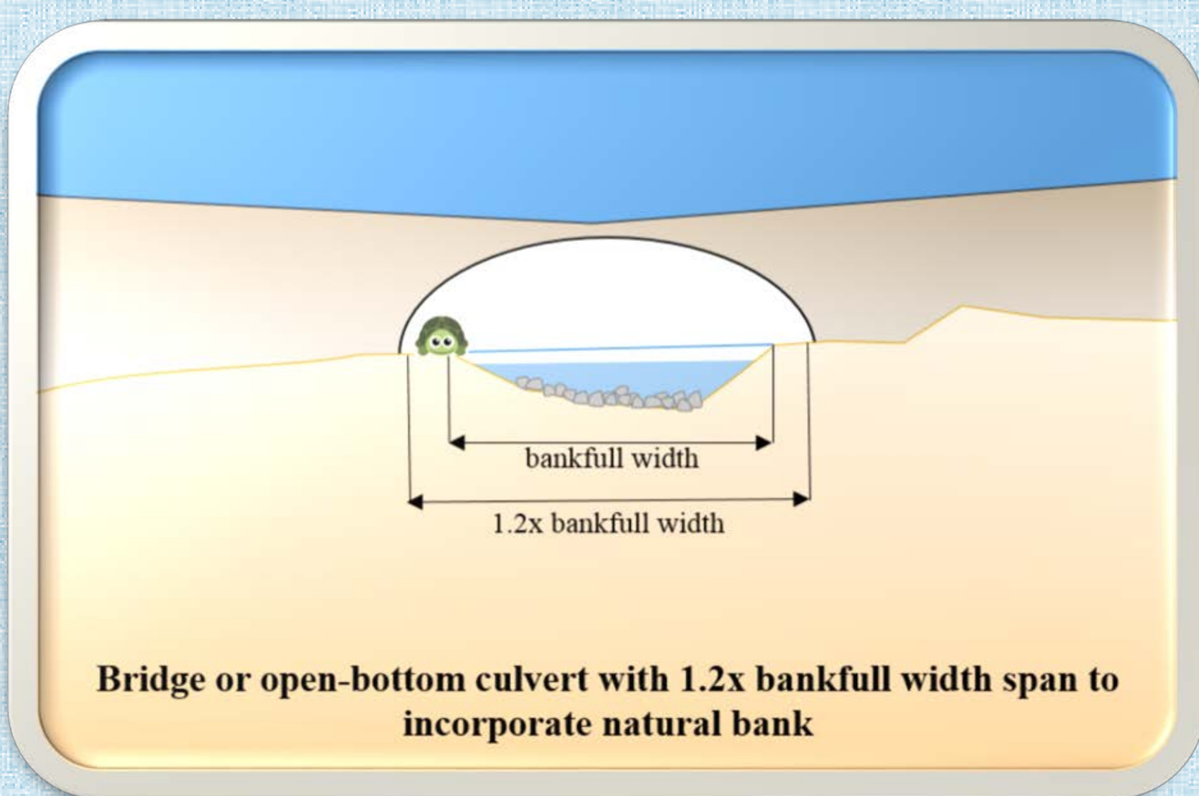


Once the new map layer is created, it will show stream crossings that have mapped habitat for Terrestrial Corridor Species on both sides of a stream crossing (see Figure 10.8) and those that have mapped habitat on one side of a stream crossing with suitable Land Use/Land Cover (LULC) habitat polygons on the other side (see Figure 10.10). A wildlife habitat passage will likely be required in both instances.

10.5.4 Requirements for Construction

Once an applicant has determined that the project occurs within TCS habitat and would cause fragmentation of that habitat, N.J.A.C. 7:13-12.7 requires the project to incorporate "a preserved or restored natural bank of sufficient width to allow the species to pass through the structure." Where feasible, the Department recommends a bridge or open bottom culvert that spans 1.2 times the bankfull width to allow for passage of terrestrial species (as shown in Figure 10.17 below). *Bankfull width* is a measurement of flow discharge at the point before a stream overflows its banks and should be measured in stable conditions where significant erosion is not evident, which may be equivalent to the 2-year flood elevation. Bankfull width is calculated by averaging the width at the proposed structure location and a point within 200 feet upstream and downstream. Width should be measured at straight sections of channel and where the conditions are representative. See the River and Stream Continuity Project, referenced in Section 10.5.5, for more detail.

Figure 10.17: Required Widths for Passage



Please note that under N.J.A.C. 7:13-12.7(f), a new or replacement bridge, three-sided culvert, or arch culvert is required to completely span the regulated water to preserve the natural channel unless the applicant can demonstrate another type of culvert is acceptable. Since calculations are required to meet this standard, the Department anticipates that the burden of additional calculations to meet N.J.A.C. 7:13-12.7(d)3 and 12.7(e)3 for the incorporation of wildlife passages will be minimal.

Figure 10.18 below shows a Massachusetts bridge before wildlife passages were incorporated by extending the span of the bridge and restoring the bank on both sides to allow for movement of terrestrial species. Figure 10.19 (below Figure 10.18) shows the bridge after the incorporation of the passages and is an example of a 1.2 times bankfull span bridge replacement with a restored natural bank.

Figure 10.18: Bridge Before Installation of Wildlife Passage

©MassWIldlife/MassDOT

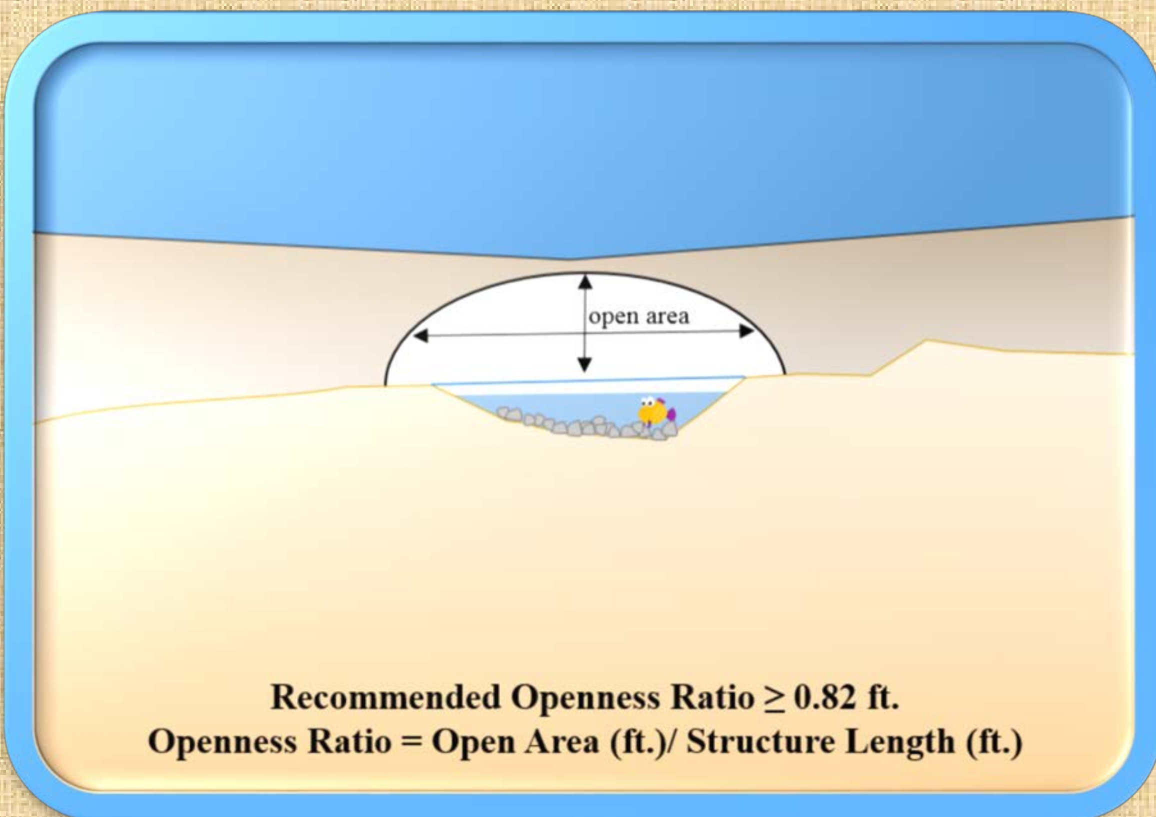
Figure 10.19: Bridge Replacement at 1.2 Times Bankfull Width for Installation of Wildlife Passage

©MassWIldlife/MassDOT

Bridge or open bottom culverts should have natural substrate to create continuity of habitat. Wildlife passage size will depend on the species documented and should be created on both sides of the bridge or culvert to allow for movement for a suite of species.

When designing a new bridge of culvert, the Department encourages applicants to design the structure to a height of at least six to eight feet and to maximize the openness ratio. *Openness*, a measure of the cross-sectional area of a structure divided by its crossing length (e.g., a box culvert's openness is (height x width)/length), should be a minimum 0.82 feet (see Figure 10.20), but the recommended range is 1.64 to 2.46 feet. Please see the River and Stream Continuity Project for more detail on this standard.

Figure 10.20: Openness



The Department will work with the applicant to determine the specific width and structure of the wildlife passage for each project and how to balance changes in water elevation and riparian impacts. However, a hierarchy with general guidelines to determine what type of passage will be required is provided on page 266. If the applicant determines that any step in this hierarchy is not feasible for their project, justification will be required prior to moving to less optimal crossing designs. General dimensions for wildlife passages based on TCS species are provided in Figure 10.21 on the following page.

Figure 10.21: Species-Specific Requirements for Wildlife Passages

SPECIES GUILD	FHA SPECIES	TYPE	SPAN	SUBSTRATE	SHELF MATERIAL	SHELF LOCATION	SHELF WIDTH (internal)		SHELF HEIGHT (internal)	
						recom'd	*recom'd*	*min*	*recom'd*	*min*
low mobility	amphibians, Allegheny woodrat	culvert/bridge/open bottom structure	1.2x bankfull width	open-bottom, natural substrate	no gabion baskets or exposed rip-rap	both sides	2'	18"	2'	1'
		box or 4-sided culvert /circular		backfill >6" native substrate						
moderate/ high mobility	bobcat, snakes, turtles	culvert/bridge/open bottom structure	1.2x bankfull width	open-bottom, natural substrate	no gabion baskets or exposed rip-rap	both sides	4'	3'	4'	3'
		box or 4-sided culvert /circular		backfill >6" native substrate						
NOTES:	maximize continuity of native vegetation/soils adjacent to/within structure; consider adding rocks/logs for cover									

SPECIES GUILD	FHA SPECIES	SUBSTRATE	WIDTH (internal)		HEIGHT (internal)		LENGTH		SPACING of PASSAGES		GRATED TOP flush with road surface		GUIDE WALL/FENCING		
			recom'd	*min*	*recom'd*	*min*	*recom'd*	*max*	*recom'd*	*max*	*recom'd*	*min*	Height	Material	Orientation
low mobility	amphibian, Allegheny woodrat	open-bottom preferred	2'	18"	2'	1'	≤ 40'	125'	120'	200'	entire length	at ends	≥ 1.5'	solid/opaque material (concrete, treated wood)	angle 25-45 degree from passage
moderate mobility	snakes, turtles	open-bottom preferred	4'	3'	4'	3'	≤ 40'	125'	500'	1,000'	entire length	at ends	3-6'	fine wire mesh/ hardware cloth/welded-wire mesh (max 1"x 1")	angle 25-45 degree from passage
PASSAGE NOTES:		tunnel should be perpendicular to road, situated at base of slope coming off road grade, completely level or minimum grading (3%) on divided highways continuous, shorter, more numerous tunnels better than one large													
FENCING NOTES:		no gaps between fencing and passage; fencing should be buried 6-10"; when possible fencing that curves away from road preferred													

Hierarchy for Wildlife Passages

1. The span is increased to 1.2 times bankfull width (or greater) to incorporate a natural or reconstructed bank.

2. If unable to incorporate a bank, a wildlife passage measuring the recommended width and height for the documented species is required on **both** sides of the culvert/bridge.

    - If recommended passage dimensions are not feasible, a passage measuring minimum width and height is required on **both** sides of the culvert/bridge.

        - If passage on both sides is not possible without adverse impacts, one passage of recommended dimensions or one passage of minimum dimensions may be acceptable but only if the applicant provides a hydraulic analysis showing adverse impacts to crossing structures on both sides. The Department will determine which side of the structure the shelf will be installed on to maximize benefits to wildlife.

3. If installing a wildlife passage within the immediate stream corridor is not feasible, separate, dry, wildlife passages may be installed on **both** sides of the stream within the riparian corridor and as close to the stream as possible to maintain continuity as wildlife moves through its habitat.

4. In the rare circumstance that passages cannot be installed within a stream corridor or immediately adjacent to that stream corridor due to physical or logistical factors (e.g., extreme topography or insurmountable landscape characteristics), the applicant will be required to investigate other potential wildlife crossing locations within the vicinity. In this situation, the Department will work with the applicant to review suitable alternative locations.

5. If the applicant has thoroughly investigated all previous options and presented the Department with an unacceptable wildlife passage plan, such as one in which the Department determines the proposed plan will cause more environmental harm than benefit through the construction of the passage, the Department can guide the applicant to a mitigation alternative through the hardship exception at N.J.A.C 7:13-15.1(b)3. Under this provision, the Department has the discretion to find an "alternative requirement…that provide(s) equal or better protection to…the environment." In this situation, the "alternative requirement" could be an appropriate monetary contribution to a specific wildlife passage fund to be administered by the Division of Fish and Wildlife, Endangered and Nongame Species Programs. **This option will only be considered by the Department in unique and exceptional cases since wildlife passage is required under N.J.A.C 7:13-12.7.**

The following requirements apply to **all** wildlife passages:

- Depending on the species documented and the landscape features, creation of an artificial shelf will allow terrestrial passage under the bridge or culvert. The shelf:
  - Must be above the 2-year flood elevation. Where a discernable stable bank exists with no signs of erosion, the shelf may be at the elevation of the existing upstream and downstream bank, provided it is above 1-year flood elevations so that the shelf does not flood frequently with future increases in stormwater elevation as climate continues to shift.
  - Cannot be constructed of gabion baskets or rip-rap because the rip-rap settles, creating gaps between the wire and the rocks, making the movement corridor unsuitable for some species. Figure 10.22 below shows an early example of a crossing project in New Jersey along the Atlantic City Expressway utilizing unmodified gabion baskets. Common acceptable materials include concrete and sediment-choked rip-rap (rip-rap with all voids between stones filled in completely by soil, sand, or smaller stones). The shelf should incorporate natural substrate to create continuity of habitat from the riparian corridor.
- The passage must tie-in with the existing bank and be of gradual slope. No steps are permitted.
- Regardless of the type of structure and whether the wildlife passage is natural or artificial, N.J.A.C. 7:13-12.7 also requires that "the applicant shall additionally adopt appropriate measures where necessary to encourage the species to pass through the structure." The Department will determine when additional measures, such as guide walls or fencing, are necessary to ensure the success of the wildlife passage. An example of guide fencing is illustrated in Figure 10.23 on the next page.

Figure 10.22: Early Wildlife Passage Utilizing Unmodified Gabion Baskets

Figure 10.23: Guide Fencing

Where passage under the bridge or culvert is not feasible, the applicant may be required to install wildlife-specific passages underneath the roadway outside of the watercourse. To maximize effectiveness and reduce the need for associated fencing, these passages should be installed within the floodplain and/or riparian zone and as close to the stream as possible. In these situations, the Department will work closely with the applicant and engineers to ensure that appropriate, cost-effective structures are installed. Figure 10.24 below shows an example of a wildlife-specific passage designed for amphibians and reptiles.

Figure 10.24: Wildlife-Specific Passage for Amphibians and Reptiles

10.5.5 Sources for More Information

- The Department's Division of Fish and Wildlife is in the final stages of developing its *Connecting Habitat Across New Jersey* (CHANJ) project, which is a guide for strategic habitat conservation in the State of New Jersey. The CHANJ document will include guidance on road mitigation projects to increase habitat connectivity and best management practices for wildlife passages. Please visit http://www.nj.gov/dep/fgw/ensp/chanj.htm for updates on this project.

- The River and Stream Continuity Partnership has developed the *Massachusetts River and Stream Crossing Standards*, which includes design standards and construction best management practices for wildlife passages and is available online at https://streamcontinuity.org/aquatic_connectivity/crossing_design/ma_crossing_standards.htm.

- The State of Minnesota has developed the *Best Practices Manual for Meeting DNR General Public Waters Work Permit GP 2004-0001*, which addresses wildlife passages and is available online at http://www.dnr.state.mn.us/waters/watermgmt_section/pwpermits/gp_2004_0001_manual.html.

- Staff of the Department's Division of Land Use Regulation and Division of Fish and Wildlife's Endangered and Nongame Species Program are also currently working to develop a technical guidance document for wildlife passages.

10.6 Riparian Zone Disturbance Standards

When constructing or reconstructing a bridge or culvert, construction activities will involve disturbance to vegetation in the riparian zone. Section 6 of this manual provides a general description of the riparian zone standards, but N.J.A.C. 7:13-11.2 sets specific limits on disturbance for several bridge and culvert activities.

N.J.A.C. 7:13-11.2(g) contains requirements for bridge or culvert construction or reconstruction along public roadways or railroads. Disturbance limits for this activity are based on the width of the riparian zone. However, when the proposed disturbance exceeds the limit, a permit may still be issued without the need to undergo the hardship exception process. Disturbance must still be minimized, justification is required for the proposed disturbance, and mitigation will be required (see Section 7 for information regarding mitigation requirements). Where the riparian zone measures either 150 or 300 feet in width, the applicant must demonstrate a compelling reason to disturb the riparian zone prior to obtaining authorization for any disturbance. Such a demonstration includes an alternatives analysis that must identify any feasible design alternatives that will further minimize riparian zone disturbance or avoid it altogether.

If the proposed project is located along a lawfully existing public roadway, disturbance in not counted against the limits in Table 11.2 under N.J.A.C. 7:13-11.2(f), as explained in Section 6.4.3, subject to each of the following conditions:

- **The riparian zone vegetation loss is less than one acre, project-wide, even if disturbance to multiple riparian zones is proposed. The one-acre limit is applied project-wide, not to each riparian zone.**
- **All disturbance is contained within an actively disturbed area.**
- **All disturbance is located in the existing right-of-way or easement. Proposed rights-of-way and easements are not sufficient to qualify for this exemption.**
- **The applicant is a public agency.**
- **All disturbance is limited to the embankment carrying the existing road.**

N.J.A.C. 7:13-11.2(h) contains the requirements for bridge or culvert construction or reconstruction for a private driveway serving a single-family dwelling or duplex or other types of buildings. Driveways in this category include those serving residential subdivisions, multi-residence buildings, commercial and retail facilities, critical buildings, industrial facilities, office parks, and others. To obtain authorization to construct a bridge or culvert for access to any building, the applicant must first demonstrate that they cannot access the property without having to cross the watercourse. This demonstration includes obtaining an access easement through other properties. If such an easement cannot be obtained, the disturbance associated with the proposed crossing cannot be allowed.

If a lot was created or subdivided after November 5, 2007, the applicant must demonstrate that none of the lots are either served by an access roadway or have a valid authorization from the Department to construct a new roadway. If the applicant can provide such a demonstration, the amount of riparian zone disturbance is limited to the amount that would have been allowed to access the original parcel prior to its subdivision. Additional requirements apply to roadways, depending on the type of building they serve. See N.J.A.C. 7:13-12.6 and Section 9.5 of this manual for more information.

N.J.A.C. 7:13-11.2(u) contains requirements for footbridges. If the applicant cannot limit disturbances as specified in Table 11.2, they must demonstrate a compelling public need to justify the additional disturbance.

SECTION 11
UTILITY LINES

As detailed in Section 6 of this manual, the riparian zone is the land and vegetation within and adjacent to a regulated water. Since riparian zone vegetation is so important for the health of the regulated water, the removal of this vegetation is discouraged by the FHACA Rules. Consequently, all disturbances to vegetation, soil excavation, and construction within riparian zones are considered regulated activities and require approval from the Department. Utility lines often impact riparian zones. Therefore, they are regulated activities, requiring permits for their maintenance and construction.

This section provides guidance regarding the types of authorizations and permits available for utility line projects under the FHACA Rules and how these projects should be designed and constructed to maintain the integrity of the riparian zone and other regulated areas. Section 11.1 explains what is considered a utility line under the FHACA Rules. Section 11.2 discusses how to minimize impacts to regulated areas and includes an explanation of the permits-by-rule and the general permit-by-certification that apply to utility line projects. Section 11.3 describes the standards for individual permits for utility lines.

11.1 What are Utility Lines?

For the purposes of the FHACA Rules, utility lines are generally linear and include both above and below-ground lines conveying gases, liquids, electrical energy, and communications, varying in scale from a single building service to large interstate transmission lines. The term also includes the poles or towers that support above-ground lines as well as small, online, above-ground structures that support below-ground infrastructure. The FHACA Rules also regulate access for the installation and maintenance of these lines, including but not limited to, the construction of access roads, laydown areas, additional temporary workspace, pipe yards, and drill pads.

Examples of above-ground utility lines include electrical transmission lines, the towers or monopoles that support them, and any auxiliary equipment mounted to the support towers, such as cellular equipment, transformers, equipment cabinets (unless the Department considers them to be habitable structures as explained in Section 9.3.1 of this manual), and pad-mounted emergency generators intended to continue operations during a power outage (such as at a water or sewer pump station). Stand-alone towers that only transmit or receive electromagnetic waves through the air, such as radio, television, or telephone transmissions, are not considered above-ground utility lines unless they are collocated on existing above-ground infrastructure or are addressed under an existing, valid flood hazard area approval.

Examples of below-ground utility lines include gas and petroleum pipelines, potable water and sanitary sewer lines, and small, online, above-ground structures that support below-ground infrastructure, such as meter sites, valves, pig launchers, and receivers.

11.2 Minimizing Impacts to Regulated Areas

Under the FHACA Rules, impacts to regulated areas must be minimized. The Department encourages applicants to reduce impacts associated with utility lines by:

- Collocating new infrastructure along existing corridors, such as within and along roads, and the rights-of-way of existing above and below-ground utility lines
- Locating disturbances, like temporary workspaces, stockpiles, storage areas, and pipe yards, outside of regulated areas
- Locating disturbances within areas that have been previously disturbed, like agricultural fields, gravel areas, or lawns
- Designing projects to meet the standards of a permit-by-rule (see Section 11.2.1)

In some situations, disturbing and placing equipment in a regulated area, like the flood hazard area, is unavoidable. In these cases, all necessary means must be taken to ensure that the activity is temporary in nature and that equipment and stockpiles required for construction are removed within six months. If equipment and stockpiles cannot be removed within six months, activities will be considered by the Department on a case-by-case basis provided the activity is intended to be temporary and is approved by the Department.

The Department has identified eight activities related to utility lines that have a minimal impact on the environment. For these specific activities, seven permits-by-rule, which do not require written approval to undertake, are available as well as general permit-by-certification 15, which is applicable in emergency situations and may be obtained through the Department's online permitting system (see Section 11.2.2).

Section 3.1.1 and Section 3.1.2 of this manual provide general information on permits-by-rule and general permits-by-certification, respectively. To qualify for one of these permits, the project must meet certain general conditions (see Section 3.4 of this manual), and the specific requirements of the permit-by-rule or general permit-by-certification, explained below.

11.2.1 Permits-by-Rule

Above-ground utility lines will qualify for permits-by-rule 33 through 35 if the respective conditions are met for the placement of:

Utility poles	**Permit-by-rule 33**
Utility open-framed towers	**Permit-by-rule 34**
Utility monopoles	**Permit-by-rule 35**

In general, these permits-by-rule do not authorize the removal of trees in a riparian zone, and all cables and wires supported by these structures or poles must be situated at least one foot above the flood hazard area design flood elevation. For the placement of utility poles, no disturbance is permitted within 10 feet of any top of bank (with a few exceptions listed at N.J.A.C. 7:13-7.33). In the cases of permit-by-rule 34 and permit-by-rule 35, the towers or poles cannot be located within a floodway or within 25 feet of top of bank. Additionally, in a fluvial flood hazard area, the footings of each tower must lay no more than 12 inches above grade, and the diameter of monopoles must be no greater than five feet.

Below-ground utility lines will qualify for permits-by-rule 36 through 39 if the respective conditions are met for:

Placement of a line using directional drilling or jacking	**Permit-by-rule 36**
Placement of a line under existing pavement	**Permit-by-rule 37**
Attachment of a line to a roadway or railroad crossing a regulated water	**Permit-by-rule 38**
Placement of a line that does not cross a regulated water	**Permit-by-rule 39**

In general, these permits-by-rule do not authorize disturbances to regulated waters, require all disturbed areas within the flood hazard area to be returned to preconstruction topography, and, except for permit-by-rule 38, do not permit the disturbance of any riparian zone vegetation. Also, the line must be sealed from leakage, manholes may not be constructed within 10 feet of top of bank, the top of any manhole in a floodway must be flush with the ground, the top of any manhole in a flood fringe must be flush with the ground where feasible, and any manhole in a flood hazard area must have a watertight cover. Additionally, work above or below existing culverts must be accomplished without displacing or damaging the existing bridge or culvert.

For permit-by-rule 36, the top of the utility line must be located at least four feet below the stream invert, and the utility line must remain horizontal at this depth for at least 10 feet on both sides of the channel. For permit-by-rule 38, the utility must be located on the downstream side of a bridge or culvert at least one foot above the flood hazard area design flood elevation, and for permit-by-rule 39, no disturbance may be located within 25 feet of top of bank when not crossing a regulated water.

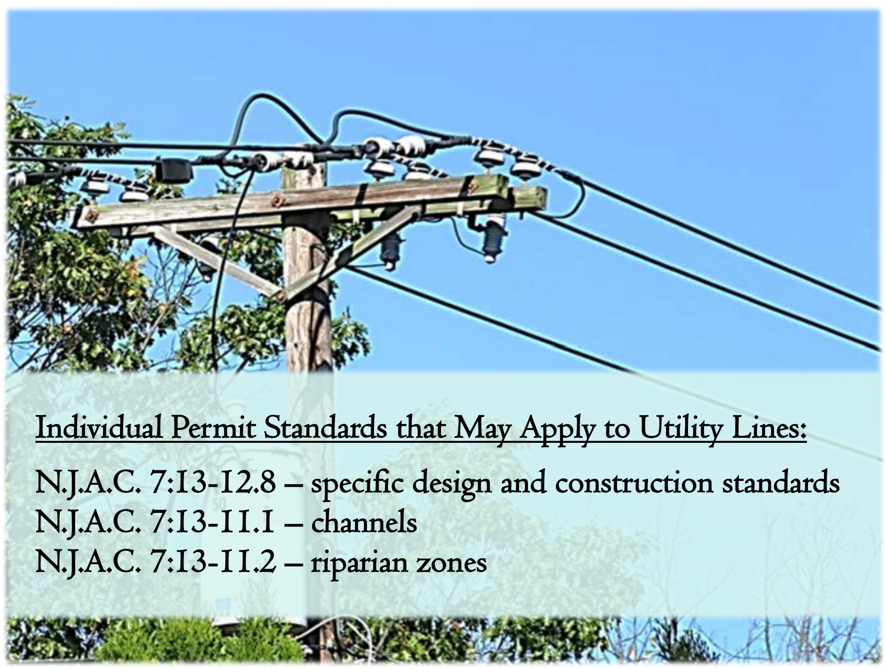
11.2.2 General Permit-by-Certification 15

General permit-by-certification 15 may be obtained for the in-kind replacement of utility lines damaged by an event that the Governor of New Jersey has declared a State of Emergency or that FEMA has declared a major disaster in New Jersey. These utility lines must be maintained by a public entity that has determined immediate action is warranted to protect public health, safety, and welfare or the environment. An engineering certification (see Section 3.3.1) is required as part of the application for general permit-by-certification 15 to comply with the design and construction standards at N.J.A.C. 7:13-10, 11, and 12, except for the timing restrictions at N.J.A.C. 7:13-11.5, although timing constraints do apply for when work must commence and be completed under the general permit-by-certification (see N.J.A.C. 7:13-8.15).

11.3 Individual Permit Standards

If a utility line project is located in a regulated area but does not qualify for the permits-by-rule listed above or for general permit-by-certification 15, an individual permit must be obtained for that project. The individual permit requirements for the specific design and construction standards for utility lines are at N.J.A.C. 7:13-12.8.

If the utility line project impacts channels and/or riparian zones, it must also comply with the requirements at N.J.A.C. 7:13-11.1 and 11.2, respectively. Within channels, activities for the installation of utility lines must be avoided where possible. Where they are unavoidable, the disturbance must be temporary in nature and limited to the minimal amount necessary to accomplish the installation. The utility lines must be perpendicular to the channel, and after the installation is complete, the channel must be restored to pre-existing conditions, including the maintenance of low flow aquatic passage through the crossing and the preservation and enhancement of the aquatic habitat.



All utility line projects resulting in the disturbance of riparian zone vegetation must be avoided where possible, as required by N.J.A.C. 7:13-11.2(b), and where unavoidable, the disturbance must be minimized to the amount necessary to accomplish the project. Minimization may be accomplished through a variety of methods, including situating the project as far from the regulated water as possible and limiting the disturbance to previously disturbed areas. All vegetation that is temporarily disturbed must be replanted. If vegetation is disturbed within 150 feet of the top of bank in a 300-foot riparian zone, the project must comply with the requirements at N.J.A.C. 7:13-11.2(d). Specifically, the project must have no practicable alternative that would have less adverse impacts on regulated areas, must result in the minimal feasible alteration to the riparian and aquatic ecosystem, and must be in the public interest.

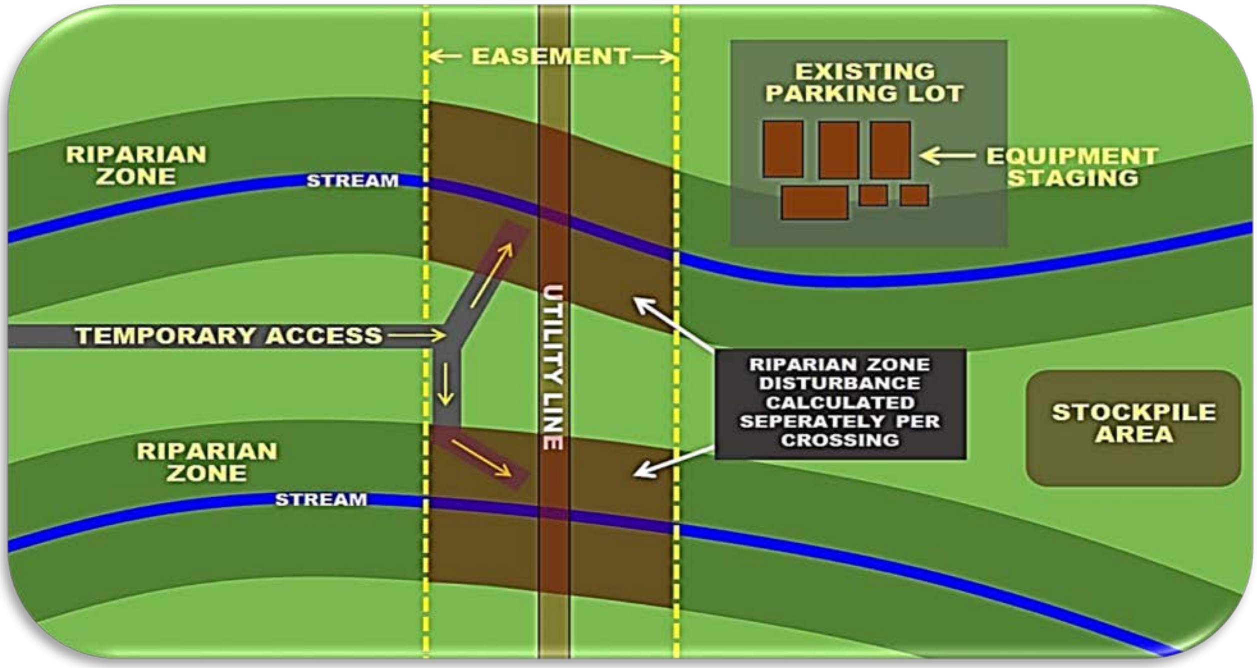
Table 11.2 establishes the maximum allowable area of riparian zone vegetation that can be temporarily or permanently cleared, cut, or removed per riparian zone crossing. To calculate the area of disturbance, add the area of vegetation to be cleared within the project's limit, as shown on the site plan, to the area under the canopy of any trees to be cleared. Permanent impacts to farm fields or other areas that are only seasonally vegetated must be included in the calculation. However, any temporary impacts to actively disturbed areas, such as farm fields and lawns, do not need to be included, provided these areas are adequately stabilized and replanted in the manner described at N.J.A.C. 7:13-11.2(z).

The construction standards for new utility lines in riparian zones are found at N.J.A.C. 7:13-11.2(k), and the construction standards for activities for the reconstruction, upgrade, expansion, and maintenance of existing lines are found at N.J.A.C. 7:13-11.2(l). However, the standards at N.J.A.C. 7:13-11.2(l) apply only to activities within existing rights-of-way. Impacts outside of existing rights-of-way must meet the requirements of N.J.A.C. 7:13-11.2(k) for new utility lines. The maximum allowable riparian zone vegetation disturbance for a new utility line is 30 square feet per linear foot of utility line, which results in an average 30-foot-wide permanent right-of-way that may be maintained in the future. This allows for the permanent right-of-way width to vary along the utility line. In some cases, like at a stream or wetland crossing, the right-of-way width may be reduced to less than 30-feet-wide but expanded beyond the crossing area to limit disturbance in sensitive areas. Varying the width of disturbance is encouraged to minimize impacts to sensitive environmental areas, such as forested areas, streams, wetlands, and steep slopes. If additional, permanent right-of way is justified, mitigation must be provided for the impacts. In addition, if the limits in Table 11.2 are exceeded in a 300-foot riparian zone, mitigation must be provided for the entire area of disturbance (see N.J.A.C. 7:13-13 and Section 7.1 of this manual for more information).

IF THE LIMITS IN TABLE 11.2 ARE EXCEEDED IN A 300-FOOT RIPARIAN ZONE, MITIGATION MUST BE PROVIDED FOR THE ENTIRE AREA OF DISTURBANCE.

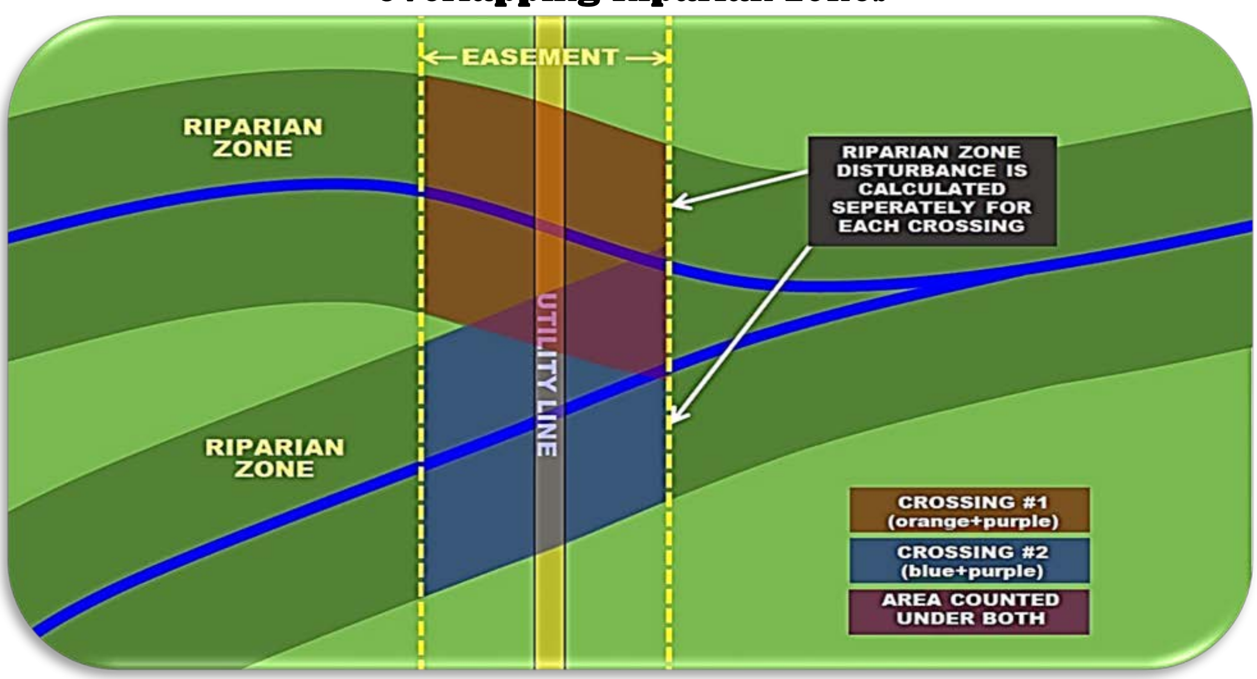
N.J.A.C. 7:13-11.2(k) and (l) also include standards for access to the project location per crossing. This access includes not only access roads but all disturbances to the riparian zone outside of the permanent right-of-way. Examples include temporary workspaces, lay-down areas, drilling pads, and additional temporary workspaces for staging. The maximum allowable disturbance to riparian zone vegetation is calculated per crossing and must be temporary in nature and restored and replanted after the utility line installation is complete. All impacts must be minimized as required by N.J.A.C. 7:13-11.2(b), including locating temporary work spaces, staging, and stockpile locations outside of the riparian zone or in areas that are actively disturbed, such as agricultural fields or gravel lots (see Figure 11.1 on the next page).

Figure 11.1: Calculating Riparian Zone Disturbance for Multiple Stream Corridors with Separate Riparian Zones



In cases where stream corridors have overlapping riparian zones, the disturbance for each crossing and access should be independent of the riparian zone of the other stream (see Figure 11.2, below).

Figure 11.2: Calculating Disturbance for Stream Corridors with Overlapping Riparian Zones



In addition, all temporarily impacted areas must be restored to preconstruction conditions and replanted as required by N.J.A.C 7:13-11.2(z), and mitigation may be required for permanent impacts.

Some activities, such as routine vegetation maintenance within existing rights-of-way and pipeline anomaly investigations, may be accomplished under a flood hazard area individual permit and the corresponding Statewide freshwater wetlands general permit 1 at N.J.A.C 7:7A-5.1. In these cases, utility companies will be required to submit information via e-mail to the Department indicating the location and timing of maintenance and investigations. The Department will review such submittals within 14 days and will respond to the e-mail request if the project will have no impact on threatened or endangered species, or the Department may impose additional conditions, such as timing restrictions, for the protection of threatened or endangered species that may be impacted. Where utility projects include large system upgrades, such as the installation of cathodic protection along several miles of pipelines or the upgrade of electrical transmission lines to carry increased voltage, a separate new approval is required from the Department, which usually consists of a combined freshwater wetlands and flood hazard area individual permit application.

Photo Courtesy of Kelly Klein, Princeton Hydro LLC

SECTION 12 BANK STABILIZATION AND CHANNEL RESTORATION

One basic function of a watercourse is to transport sediment. A stable watercourse is one that transports the same amount and type of sediment without a long-term, net increase in either *aggradation* or *degradation*. Aggradation is a process whereby a channel fills with sediment that would otherwise be carried by flowing water while degradation is a process whereby a channel erodes and deepens. Therefore, for a stable watercourse, the channel configuration is in sync with inputs of flow and sediment, and the average channel dimensions (width, depth, and slope) do not change appreciably over time. Such a watercourse is said to be in dynamic equilibrium with its flow regime and sediment load. Watercourse stability is essential since instability may result in adverse impacts to the environment and public safety, as described in Section 12.1.

While a watercourse can experience short-term aggradation or degradation, such events do not necessarily indicate that the watercourse is unstable; overall watercourse stability is a function of the duration of the aggradation or degradation. Section 12.2 discusses how to determine if a watercourse is stable or unstable.

Correcting an instability is a regulated activity under the FHACA Rules, with the specific design and construction standards for bank stabilization and channel restoration activities located at N.J.A.C. 7:13-12.14. Some of the factors that must be considered before designing a stabilization project are discussed in Section 12.3, including a description of some potential causes of instability, a discussion of bankfull flow, and an explanation of the various stabilization methodologies. Section 12.4 discusses the permits and authorizations that are available for bank stabilization activities. Some of the individual permit standards for these activities are explained in Section 12.5, and Section 12.6 contains the individual permit application requirements.

12.1 The Consequences of Watercourse Instability

As discussed above, watercourse instability ultimately expresses itself as either aggradation or degradation of a channel and its banks, and both processes can result in consequences to the environment and to public safety and welfare.

Aggradation results in a shallower channel, which in turn, reduces the conveyance capacity of the channel. As a result, the channel may also get wider to maintain conveyance of flow. Aggraded watercourses may cause harm to aquatic biota as they are associated with increased water temperatures, decreased dissolved oxygen, and buried substrate, which can smother certain aquatic biota and disrupt the life cycles of other aquatic organisms. Also, the corridors of an aggraded watercourse may no longer be amenable to fish passage during low flow conditions.

Conversely, degradation results in deeper channels, which have more vertical bank slopes and taller banks as a result of the lowering of the channel bed. Once the bank height exceeds a critical point, the bank will fail and collapse, resulting in an additional sediment load into the watercourse. Because watercourses transport sediment, the newly introduced sediment will result in turbidity and a decrease in water quality. Ultimately, this sediment will be deposited downstream, which may result in aggradation.

Photo Courtesy of Kelly Klein, Princeton Hydro LLC

Degradation can also impact ecosystem productivity. The deepening of a channel can cut off its connection to its overbanks. *Overbanks* are the areas outside of the channel that are directly adjacent to the banks. These areas experience periodic flooding. In a well-connected system, the overbanks trap some of the water as a flood recedes, which can create seasonal habitat for a variety of species for part of their life cycles. However, as a watercourse degrades, floodwaters cannot as frequently access the overbanks, and the habitat is degraded, if not lost. Also, increased bank erosion associated with degrading channels will lead to deposition of clays and silts downstream of the eroding areas, which can clog void spaces that may exist on a channel bottom. These void spaces provide habitat for benthic macroinvertebrates, and the loss of this habitat adversely impacts spawning.

Furthermore, in a degraded channel, greater amounts of flow are required to overtop channel banks. Flows that would normally overtop the banks in a stable condition can no longer do so, and the energy associated with those flows is not dissipated in the channel's overbanks. As a result, that energy becomes trapped within the banks, leading to additional erosion of the channel bottom and/or its banks.

Both the widening of watercourses through aggradation and the deepening of watercourses through degradation can also undermine vegetation situated near the channel banks, which adversely affects the functionality of the riparian zone (see Section 6 of this manual). For example, filtration of runoff that would normally occur within the riparian zone would be short-circuited, which may lead to additional sediment and nutrient loading in the watercourse. Additional sediment loading can create further instabilities as it alters channel form. Furthermore, with the loss of riparian zone vegetation, habitat that exists outside of, but near, the channel banks would be lost. In addition, lost canopy cover over certain watercourses can increase the amount of solar radiation the watercourse receives, which can result in the thermal degradation of the watercourse system, including warmer water temperatures, which leads to less dissolved oxygen in the water.

Finally, should a watercourse significantly aggrade or degrade, manmade structures may be threatened, including road crossings (bridges and culverts), utility crossings, homes, sheds, and retaining walls, which may in turn threaten public safety and welfare. If a structure, such as a single-family dwelling, is situated very close to the banks of an eroding watercourse, the foundation of the building could be exposed, potentially threatening its stability. Where a channel bed is downcutting, footings of bridges could be exposed, jeopardizing the stability of the bridges and the roadways they carry. In addition to the safety issue this causes, it also leads to economic loss as monies that could be devoted to other purposes must be reallocated to stabilize these structures. Even where no structures are present, property may be lost as banks erode.

12.2 Determining if a Watercourse is Unstable

Numerous methodologies aid in assessing whether a watercourse is unstable. Part 654 of the *National Engineering Handbook*, published by the Natural Resources Conservation Service (NRCS), is devoted to stream restoration design. Each chapter, the appendices, and the technical supplements are available from the NRCS at https://directives.sc.egov.usda.gov/viewerFS.aspx?id=3491.

The NRCS manual provides information regarding basic field indicators used to determine watercourse stability and instability.

In general, a stable system includes:

- Signs of vegetated bars and banks
- Limited erosion
- A lack of exposed utility crossings or bridge footings
- Culvert bottoms that match adjacent channel grade
- Equal bed elevation for the mouths of tributaries and the parent watercourse

By comparison, unstable watercourses show signs of either aggradation or degradation.

Indicators of degraded watercourses include:

- Headcuts
- Exposed pipe crossings
- Exposed tree roots
- Leaning trees
- Undercut banks
- Terracing
- Culverts with inverts suspended above the channel bottom
- Narrow and deep channels

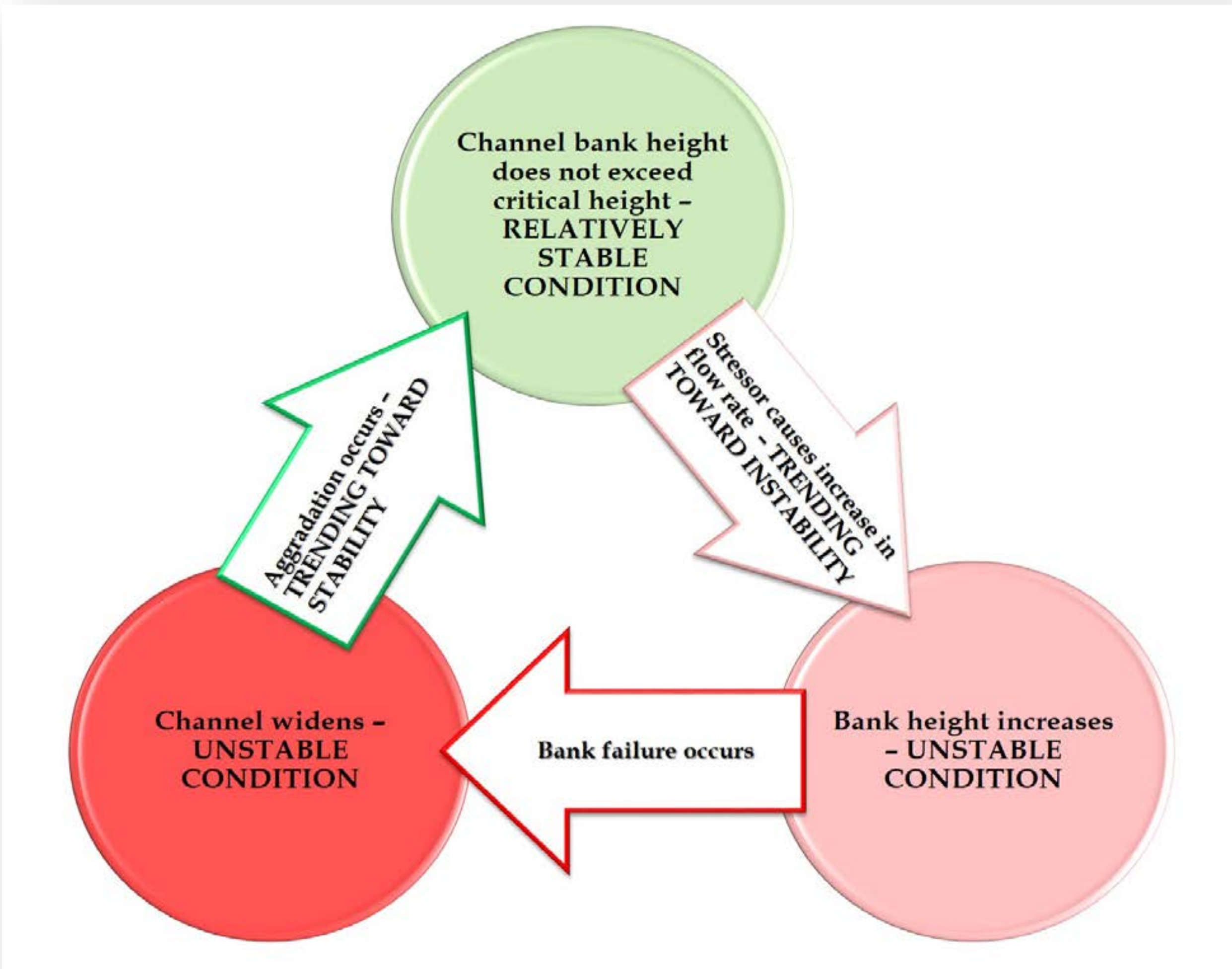
Indicators of aggraded watercourses include:

- Buried culverts and outfall structures
- Reduced bridge clearance
- Sediment deposition
- Buried vegetation
- Significant backwater in tributaries
- Dead hydrophobic vegetation at channel banks

The NRCS manual also describes several assessment models, ranging from geological to biological to geomorphological. Because watercourses are unique systems and the causes and extent of instability are wide ranging, no single system can fully guide an assessment. However, the assessment systems can aid in the understanding of the present watercourse system and the expected future status of that system. Many models rely on geomorphic studies, and this is one reason why the FHACA Rules require a professional experienced in fluvial geomorphology to design any bank or watercourse restoration project (see N.J.A.C. 7:13-12.14(b)2). For more on this requirement, see Section 12.3.2.

An example of a model described in the NRCS manual that relies on geomorphic studies is the Channel Evolution Model, which seeks to describe a predictable sequence of change in a disturbed channel system. In such a system, a disturbed channel will cycle through various stages – progressing from stable to unstable and back to stable, as shown in Figure 12.1 below.

Figure 12.1: Channel Evolution Model



While aggradation is not necessarily the last step before a watercourse stabilizes itself, the value of such a model is that it can be used to show trends in a watercourse, which are key to successfully determining if bank stabilization efforts are necessary.

Geomorphologists can recognize these trends because they understand the dynamic nature of watercourses. A watercourse naturally moves both laterally and vertically over time and is not meant to maintain the same dimensions or remain in the same location over extended periods. Therefore, some erosion and aggradation are both expected and natural. The geomorphologist can differentiate between a watercourse that is naturally trending toward stability and one trending toward instability. In cases where a watercourse is naturally trending towards stability, few, if any, corrective measures are required. True restoration efforts should focus on those watercourses that are still trending toward instability, where erosion or deposition is actively ongoing or worsening.

12.3 Selecting the Appropriate Stabilization Method

If a watercourse requires stabilization measures, many factors must be considered to determine the most appropriate method to correct the instability. The time scale (long-term versus short-term) of an observed instability can inform the manner of treatment that is the most appropriate to overcome the instability – if a treatment is, in fact, necessary. As mentioned in Section 12.2 above, an unstable channel trending towards stability may not need any stabilization measures, but if it does, these measures would be limited in scope. In contrast, a channel trending toward instability may need significant work.

Other factors include the potential causes for the instability, described in Section 12.3.1 below. An assessment of potential causes should include a review of the history of the watershed. For example, additional flow inputs from recent development (either from changes in land cover or the creation of new point discharges) may be the underlying reason for the watercourse's instability. A historical review may also inform whether the observed instability is worsening or if the watercourse is in the process of self-stabilizing.

The appropriate type of stabilization measure may also be dependent upon the extent of the instability the watercourse is experiencing. In general, if the erosion is occurring within a localized area, the corrective action should only be performed within that area. Should the instability problem extend over multiple properties, all impacted property owners will need to be involved in any proposed corrective technique since limiting the project scope to a single property will likely result in a failed stabilization. If the problem is more systemic to the entire watercourse, a more widespread solution is needed.

Also, before a stabilization method is selected and designed, bankfull flow should be calculated, as discussed in Section 12.3.2. Finally, another essential factor that must be considered prior to design is the Department's hierarchy for stabilization methods, which is explained in Section 12.3.3.

12.3.1 Identifying the Causes of Instability

Aggradation and degradation are not random events. Generally, channel instability is caused by changes in either sediment supply within a watercourse or the flow rates conveyed by the watercourse. As the frequency and magnitude of the flow discharged to a watercourse increase, erosion may result. Conversely, if the flow rate carried by the watercourse decreases beyond a threshold, sediment deposition and, consequently, aggradation will occur. Similarly, if the sediment supply to a watercourse increases, the watercourse will aggrade and become shallower. On the whole, if the increase in flow rate outpaces the increase in sediment supply, a watercourse will tend to get both wider and deeper. However, if the increase in flow rate is outpaced by the increase in sediment supply, a watercourse will tend to get both wider and shallower.

Therefore, to determine the causes of instability, the change in flow and sediment supply must first be understood. A variety of factors can alter the amount of flow and the sediment supply, including, but not limited to, the following (described in further detail below):

- Changes in the watercourse hydrograph
- Removal of vegetation along the corridor
- Point discharges (such as stormwater outfall structures) at the banks of the watercourse
- Localized obstructions
- Poorly executed channel relocations or realignments

Changes in Hydrograph

A *hydrograph* is a graph that shows the rate of flow as a function of time, depicting the amount of flow conveyed by a watercourse at any given point. A modification impacting the amount of flow in the watercourse at that point in time is referred to as a *change in the hydrograph*. With respect to watercourse stability, common causes for a change in the hydrograph include certain channel modifications and urbanization within the watershed.

Channel modifications that can result in altered hydrographs may include the construction of a new road crossing (bridge or culvert) over a watercourse or the reconstruction of an existing crossing to different dimensions. If a new crossing constructed where one did not exist previously does not, at a minimum, completely span the channel, the channel will not be able to pass flow as efficiently. The crossing acts as a dam, obstructing flow so that water backs up on the upstream side of the crossing. While the crossing will eventually pass all the upstream flow, a slower flow rate of water travels downstream than prior to construction of the crossing. Thus, the crossing has altered the hydrograph. With reduced velocities associated with lower flow rates, sediment may drop out of suspension, which can result in aggradation. For this reason, amongst others, the FHACA Rules require culverts to at least span the channel banks (see Section 10 for more information on the requirements for bridges and culverts).

Similarly, the size of a replacement crossing may alter the hydrograph. For example, when an existing bridge or culvert is upsized, some of the upstream storage associated with the existing condition may be lost, and peak flow rates could increase downstream of the crossing, meaning there will be more flow at a given time. If the increase in flow rate is severe enough, erosion may occur downstream of the crossing. Altered flow rates can also affect channel bank and bottom stability due to the change in the magnitude of the forces exerted on them.

Urbanization can also alter the hydrograph. As urbanization increases in the watershed of a given watercourse, more permeable soils and vegetated types of land cover are replaced with less pervious surfaces. This reduces, if not eradicates, the natural infiltration of rainfall. In addition, with the loss of vegetation, stormwater can no longer be taken up by root systems or lost through evapotranspiration. The result is an increase in stormwater runoff that is ultimately delivered to the watercourse. This additional volume can alter peak flow rates, which may alter the watercourse's ability to transport sediment, leading to instability.

Given time, an unstable channel will eventually correct itself. In response to changes in its hydrograph, the channel will aggrade or degrade until it achieves a new channel shape, slope, and dimension that is sufficient to convey the altered hydrograph without increasing or decreasing the sediment load. However, to avoid or minimize environmental costs or risks to property, intervention may be required before the watercourse has time to correct itself.

Removal of Vegetation

Vegetation is often removed from the banks of watercourses for the purposes of improving or preserving aesthetics (such as creating or maintaining a manicured landscape or viewshed), increasing the amount of developable land, or facilitating various construction and/or staging activities. However, the removal of vegetation can cause erosion and result in a less stable bank.

Removing vegetation from the banks of a watercourse can cause erosion and bank instability.

As mentioned, watercourse instability is a function of sediment supply and flow rate. Flow is not uniform at every point in a cross section in a channel but rather tends to be fastest in the middle of the channel and slowest along the bed and banks. This is because flow in a channel is slowed by friction, and greater friction exists where the water interacts with the channel's bed and banks. Rough surfaces also create more friction and thus resist flow better than smooth surfaces. Vegetation is a roughness factor that increases the friction of the banks, resulting in reduced velocities of both watercourse flow and overland flow than where banks are denuded of vegetation. As such, when vegetation is removed, the watercourse experiences higher than normal velocities and peak flow rates that may lead to erosion.

It is important to note that while all vegetation provides better protection for a bank than bare earth, certain types of vegetation are more protective than others. A vegetated system with stronger, deeper roots (such as trees) withstands *shear forces*, meaning perpendicular forces, to a greater degree than vegetation with weaker, shallower roots (such as grasses) because it increases the resistance strength of the streambank, as shown in Figure 12.2 below.

Figure 12.2: Resistance Strength of Trees Versus Other Types of Vegetation

Photo Courtesy of Kelly Klein, Princeton Hydro LLC

In addition, vegetation can serve to redirect flow away from a bank, which also counters erosion. Natural structural components, such as rocks, are often used in conjunction with vegetation to redirect flow, as shown in Figure 12.3 at right. In some cases, vegetation can slow velocities enough to induce sediment deposition along the bank. As such, planting certain types of vegetation to redirect flow is a common soil bioengineering technique (discussed in Section 12.3.3) to remedy an erosion problem. Protecting the stability of channels is one reason the FHACA Rules establish protections for riparian zone vegetation (see Section 6 and Section 12.5, below).

Figure 12.3: Redirecting Flow

Photo Courtesy of Kelly Klein, Princeton Hydro LLC

Point Discharges

In undeveloped conditions, runoff enters a watercourse through overland flow. However, as urbanization increases, natural drainage patterns change, and runoff is delivered to a watercourse through storm sewer pipes and outfall structures. The number of point discharges increases as land becomes further developed. Point discharges resulting from urbanization typically increase the volume of runoff and also concentrate that runoff, so more runoff reaches the channel more quickly than is natural. This may cause a watercourse to experience flash floods that it would not otherwise experience, which degrade channel stability and water quality. Therefore, properly managing stormwater runoff is crucial for maintaining stable and healthy watercourse corridors, particularly in urbanized watersheds.

Additionally, a point discharge that lacks adequate or appropriate conduit outlet protection will not properly dissipate energy, which can increase erosion. Also, the orientation of the discharge can have an impact on the degree of erosion a watercourse may experience. A discharge situated either perpendicular to or against the direction of flow in a channel can result in the production of eddies (swirling action) in the channel that can scour the channel near and around the discharge, even to the point of destabilizing the outlet headwall itself. Along smaller watercourses, the force of runoff discharged through an improperly sized or oriented pipe or other outfall can cause erosion of the opposite channel bank as well. Section 14 of this manual provides more information on stormwater management, including the design of stormwater discharges in Section 14.2.

Localized Obstructions

Localized obstructions in a channel, such as fallen trees or other debris, can block and redirect flow toward the banks of a watercourse. Redirection may impart a greater shear force on the bank than it may be able to withstand, causing localized erosion. However, not all obstructions result in channel instability. In fact, some obstructions may be beneficial in providing aquatic habitat or other niches. Therefore, a proper assessment of whether an obstruction is the cause of an observed instability must be made before the obstruction is removed.

Poorly Executed Channel Relocations or Realignments

Under N.J.A.C. 7:13-11.1(c), portions of a watercourse may be modified and replaced with new channels of different dimensions for a variety of purposes, such as to address severe erosion or flooding problems or to improve the ecological functions of the watercourse and its associated corridor. However, an improperly modified watercourse may actually cause adverse impacts to ecological functions or worsen channel aggradation and/or degradation. Improper modification usually results from a design that does not accurately represent the hydrograph in the channel (see the discussion of changes in hydrograph, above). As such, channel modifications should only be performed when there are no other feasible options that would result in less environmental disturbance. See Section 13.1 for more information about channel modifications.

12.3.2 Bankfull Flow

For the purposes of the FHACA Rules, all stabilization activities should be designed primarily for bankfull flows. *Bankfull flow* is typically considered the "stream forming flow" since this is the flow rate that will cause a watercourse to meander. At bankfull discharge, the energy of the flowing water is contained within the channel. Bankfull discharge may be calculated with any of the standard hydrologic calculation methodologies used to calculate any other flow rate (see Section 4.5 of this manual). In most cases, it is not necessary to design corrective measures for higher flow rates because at higher flow rates, the overbanks serve to dissipate the energy of the flowing waters. However, confirmation from the Department is strongly recommended prior to the start of any design work.

In a stable watercourse, the bankfull flow event is typically equated with the 1.5-year to 2-year flood event. However, determining the bankfull flow in an unstable portion of a watercourse is not possible. For example, consider a degrading watercourse where the channel bottom erodes, leading to bank failure. As a result, the channel cross section conveys more flow in the unstable condition than in the stable condition. Using this cross section to determine bankfull discharge would result in an overestimation, perhaps prompting the selection of an excessively armored channel as the most appropriate stabilization method. Hard armoring is the least-preferred measure under the FHACA Rules, as discussed in Section 12.3.3.

Similarly, where a section of a channel is to be redesigned, an overestimation of the bankfull discharge can result in the creation of an oversized channel, in which case aggradation of sediment may occur because the redesigned channel would be based on an inaccurate hydrograph, as explained in Section 12.3.1. Conversely, in an aggrading watercourse, the channel becomes shallower, and given the associated decrease in conveyance capacity, the bankfull discharge will be underestimated. As a result, a stabilization technique may be selected that is insufficient to protect the banks from eroding.

To determine bankfull discharge for an unstable portion of a watercourse, a designer may have to utilize a different, stable reach of the same channel. If this is not possible, the designer may have to analyze an analogous channel of a different watercourse. However, the relevant portions of channels that would act as bankfull surrogates may not have the same hydraulic characteristics, which is one reason that N.J.A.C. 7:13-12.14(b)2 requires a professional experienced in fluvial geomorphology to design any bank or watercourse restoration project (see Section 12.2 for more information on this requirement).

12.3.3 Stabilization Methodologies and Hierarchy

While the FHACA Rules require all bank stabilization projects to be designed by an expert in fluvial geomorphology (for reasons explained above), the rules allow the geomorphologist to select from a variety of stabilization methods and designs. However, N.J.A.C. 7:13-12.14(c) provides the following hierarchy:

1. **Restore a localized eroded bank or channel by cutting the bank to a more stable slope and planting with native, non-invasive plant species.**
2. **Implement soil bioengineering practices where cutting the bank or planting is not viable.**
3. **Use hard armoring techniques where soil bioengineering is not viable.**

For the purposes of the FHACA Rules, an unsuccessful stabilization project is one that results in either a lack of stability or a loss of environmental and ecological function that would otherwise be avoidable. To this end, the hierarchy prioritizes softer, more environmentally sensitive solutions to a stabilization problem, mirroring the Freshwater Wetlands Protection Act Rules at N.J.A.C. 7:7A, which also have jurisdiction over these types of projects.

In the case of localized erosion, it should be feasible to restore an eroded bank by cutting it back to a stable slope and planting it with native, non-invasive vegetation suitable for stabilization. In most cases, a slope of no greater than 50 percent (a ratio of two horizontal to one vertical) is recommended to stabilize an eroded bank. Where space is limited such that a 50 percent slope cannot be achieved, the eroded bank could be restored by terracing the bank to achieve a stable slope.

If the geomorphologist demonstrates that cutting the bank and planting vegetation cannot adequately restore the channel and/or fully prevent erosion due to excessive channel velocity, the use of soil bioengineering should be considered. *Soil bioengineering* is a system in which living plant materials are used as structural components. Figure 12.4 on the following page shows an example of soil bioengineering.

First, shrubs and trees are planted in a configuration that provides instant protection and support for the soil, reducing the erosive forces against the streambank. As they develop roots or fibrous inclusions, the shrubs and trees help the streambank resist sliding or shear displacement, increasing the streambank's resistance to erosive forces. Woody vegetation also provides other environmental benefits to the stream and its biota, such as allowing various and productive habitats, providing shade to reduce water temperature, offering organic contributions to the stream, shielding fish, and improving water quality.

Figure 12.4: Soil Bioengineering

Photo Courtesy of Kelly Klein, Princeton Hydro LLC

The variety of soil bioengineering techniques includes the following:

- Live stakes (insertion of vegetative cuttings into the bank)
- Live fascines (bounded long bundles of branch cuttings placed into the bank)
- Branchpacking (branches and fill placed in the bank, which is good for localized blowouts)
- Vegetated Geogrids (branchpacking but with geotextiles in between soil lifts)
- Live Cribwalls (untreated timber backfilled with soil and live branch cuttings)
- Joint planting (live stakings in between riprap)
- Brushmattress (a combination of live stakes, live fascines, and branch cuttings)

Refer to Chapter 16 of the Engineering Handbook at https://directives.sc.egov.usda.govhttps://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17553.wba for specific information concerning each of these techniques. Please note that every technique requires any riprap be installed only to the elevation of the stream forming discharge. Beyond this elevation, vegetation alone stabilizes the remainder of the bank.

According to the Standards for Soil Erosion and Sediment Control in New Jersey, available for download at http://www.nj.gov/agriculture/divisions/anr, soil bioengineering is typically appropriate where all of the following apply:

Slope failures are less than four feet in height.
Channel velocities are not excessive at bankfull discharge (see Section 12.3.2).
The pH is greater than four.
The soil is not excessively drained.
There is at least 12 inches to bedrock.
Enough physical room exists to perform grading activities.

Table 26-2 of the Soil Erosion Manual provides more specific details concerning these limitations.

Where soil bioengineering does not appear appropriate, the applicant should explore alternatives that would increase the feasibility of utilizing soil bioengineering. In certain instances, first addressing the causes of an instability (see Section 12.3.1) can allow for softer stabilization measures in lieu of hard armoring. This is one reason why the causes of an instability should be evaluated prior to designing a stabilization method.

The use of hardscape measures may be explored in circumstances where there is limited space or substantial erosive forces and neither establishing a stable slope and revegetating the stream bank nor using soil bioengineering techniques will be adequate to provide stability. For example, hardscape measures should only be considered if the force that is associated with velocity in the channel exceeds the shear force of the streambank, either alone or in combination with the possible vegetative measures, and if systemic causes of erosion cannot be adequately addressed. See Section 12.6 of this manual for further information on the engineering report requirements when hard armoring is the proposed stabilization method.

When systemic erosion occurs, the watercourse may be in disequilibrium and trending towards instability, and the specific causes of the erosion may be more difficult to pinpoint and address. The installation of green infrastructure or detention systems within the watershed may manage the erosion, in which case only a minor amount of in-channel work would be necessary. To minimize environmental disturbance, as required by the FHACA Rules, such measures must be considered before any in-channel work. However, the Department acknowledges that in many instances, implementing such measures in the watershed may be beyond the applicant's control, especially in the case of erosion control projects proposed by private entities.

12.4 Available Permits and Authorizations

Section 3 of this manual discusses the various types of authorizations and permits available under the FHACA Rules, including permits-by-rule, general permits-by-certification, general permits, and individual permits. However, bank stabilization and channel restoration activities may not be performed under a permit-by-rule. Permit-by-rule 1 at N.J.A.C. 7:13-7.1 authorizes normal property maintenance, but watercourse stabilization is not considered normal property maintenance, which consists of pruning, selective tree cutting, planting native species, and removing trash and debris by hand. Stabilizing or restoring a watercourse is a more involved activity than those allowed under this permit-by-rule.

Likewise, permit-by-rule 2 at N.J.A.C. 7:13-7.2, which allows for the repair of a lawfully existing structure, does not typically extend to bank stabilization activities. N.J.A.C. 7:13-1.2 defines a *structure* as a manmade assemblage of materials by humans, and a natural bed and bank does not meet this definition. However, permit-by-rule 2 may apply to a pre-existing, hard-armored or bioengineered stabilization measure that needs repair provided that the stabilization measure is not expanded beyond its existing limits.

Permit-by-rule 8 at N.J.A.C. 7:13-7.8 allows for construction at or below grade in a fluvial flood hazard area while permit-by-rule 9 at N.J.A.C. 7:13-7.9 allows for general construction activities in a tidal flood hazard area. While stabilization measures could be constructed at or below grade in fluvial flood hazard areas and are considered construction activities in tidal flood hazard areas, neither of these permits-by-rule applies to stabilization or restoration work because both limit disturbance to areas that are at least 25 feet from the top of bank. Since stabilization activities occur at or within the banks of a watercourse, they do not meet the limitations of permits-by-rule 8 or 9.

Similarly, bank stabilization and channel restoration activities may not be performed under a general permit. While general permit 3 at N.J.A.C. 7:13-9.3 authorizes scour countermeasures at existing bridges and culverts, this activity does not qualify as a stabilization measure for a watercourse. In fact, N.J.A.C. 7:13-9.3(a)2 limits the usage of general permit 3 to areas within or adjacent to a bridge or culvert and prohibits its use for stabilization measures along larger sections of a watercourse.

While it is not possible to perform bank stabilization or restoration under a permit-by-rule or a general permit, general permit-by-certification 3 at N.J.A.C. 7:13-8.3 is available for these activities but only if the regulated water is located on land that is actively farmed. In addition, the stabilization or restoration activity must be performed under the supervision of the NRCS or the local soil conservation district.

If the project does not qualify for general permit-by-certification 3, a flood hazard area individual permit is required, and the technical standards and limitations at N.J.A.C. 7:13-11 and 12 must be met, as explained further in Section 12.5 below.

12.5 Individual Permit Standards

In addition to the specific design and construction standards for bank stabilization and channel restoration activities at N.J.A.C. 7:13-12.14, the following additional regulatory limitations must be considered:

- In-channel construction (N.J.A.C. 7:13-11.1)
- Riparian zone disturbance (N.J.A.C. 7:13-11.2)
- Floodway fill (N.J.A.C. 7:13-11.3)
- Flood storage displacement (N.J.A.C. 7:13-11.4)
- Impacts to fishery resources (N.J.A.C. 7:13-11.5)
- Impacts to threatened and endangered species (N.J.A.C. 7:13-11.6)
- Excavation and filling (N.J.A.C. 7:13-12.3)

These limitations ensure that any method utilized to correct an instability does not result in new, distinct issues for the watercourse, the environment, or public safety and welfare. Riparian zone disturbance standards are discussed in detail in Section 6.4 of this manual, the flood storage displacement requirements are explained in Section 5, the standards for the protection of threatened and endangered species are in Section 8, and information regarding aquatic resources are found in Section 10.4. However, some specific standards relevant to bank stabilization and channel restoration activities for riparian zone disturbance, floodway fill, and impacts to fishery resources are explained in more detail below.

Riparian Zone Disturbance

In most cases, riparian zone vegetation must be disturbed to construct a stabilization measure within the channel of a watercourse. However, N.J.A.C. 7:13-11.2(i) provides standards for both the disturbance for installation and any disturbance necessary for access to the site. These two types of disturbance have separate limits that may not be combined with one another for any purpose. While an application for a hardship exception need not be made to the Department for exceeding either limit, mitigation will be required for the excess disturbance (see Section 7 of this manual for more information on the mitigation requirements). As explained in Section 6.4.1, minimization of riparian zone disturbance is required under the FHACA Rules, but it also saves the applicant the time and expense of devising and conducting a mitigation project.

Creating access to a site for the purpose of installing a bank stabilization measure may result in significant disturbance to vegetation. Therefore, access should be created in areas where the need to remove vegetation is minimal, even if such access may only be obtained through property not owned or controlled by the applicant. In such a case, the applicant will need to obtain permission from the property owner for the access.

Where vegetation must be removed for access, it should be removed selectively. For example, the applicant should avoid removing trees that provide nesting habitat. The applicant should also avoid disturbing vegetation during applicable timing restrictions to better protect the habitat and viability of threatened or endangered species. Unless the stability of a structure is in imminent danger due to bank instability, the stabilization measure should not be performed if the environmental impact associated with accessing the site is greater than the erosion problem to be corrected, as this would create more environmental harm than it would solve.

Floodway Fill

With limited exceptions, N.J.A.C. 7:13-11.3 prohibits fill in the floodway because the placement of fill or structures in the floodway can reduce the flood conveyance capacity of a regulated water, as explained in Section 4.2. This leads to additional flooding that can also result in further erosion of channel bed and banks. For information on how to calculate the location of the floodway, see Section 4.7.

Fill in the floodway refers to the placement of any fill or structure that reduces the effective cross-sectional flow area, meaning the part of the floodway that actively conveys flow. Therefore, if the addition of fill or structures does not reduce the effective cross-sectional flow area in the preconstruction condition, its placement does not constitute a prohibited instance of fill in the floodway. For example, consider a watercourse that only experienced a localized bank failure on a small section of one bank. The remainder of that bank remained in place as did the opposite bank. From a plan view perspective, it appears as if there is a hole in the bank. This hole, or missing section, cannot actively convey floodwaters because any conveyance would be blocked by the natural bank at the downstream end of the hole. As such, this hole would be considered an ineffective flow area within the floodway, and filling it would not violate the floodway fill restriction. However, please note that other factors may prohibit the filling of this hole, such as if it is providing habitat.

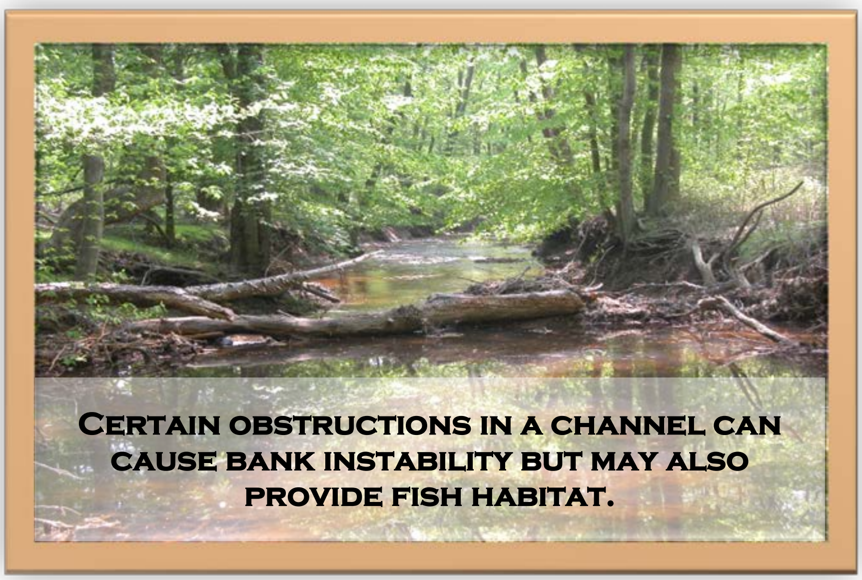
In limited cases, N.J.A.C. 7:13-11.3(c)7 may authorize fill in the floodway for the purposes of stabilizing a bank or channel where erosion has occurred. Such cases include instances where the fill is necessary to protect existing structures or trees from failure or where the ecological health or habitat value of a regulated water is improved or restored. In these cases, the Department may require a hydraulic analysis of the watercourse to ensure that the proposed work will not cause or exacerbate offsite flooding. This analysis must include the 2, 10, 25, 50, and 100-year floods as well as the flood hazard area design flood as required by N.J.A.C. 7:13-12.1(i). See Section 4.6 of this manual for more information on hydraulic analyses.

On occasion, an applicant may attempt not only to correct an erosion problem but also to reclaim any lost land area. Such land does not typically fit into the allowance provided at N.J.A.C. 7:13-11.3(c)7 unless the area to be reclaimed is an ineffective flow area. Reclaiming land in conjunction with watercourse stabilization is not permitted in most cases because it may result in a further obstruction to flow, which can alter the conveyance capacity of the channel. Further erosion and additional flooding may result either onsite or offsite. Therefore, arresting erosion in place should be the goal when designing projects to counter erosion.

It is important to note that even where fill is not placed in the floodway, significant reaches of stabilization measures, such as the placement of hard armoring, can have an impact on the amount of flooding in more frequent storms. The replacement of earthen or vegetated banks with hardscaping reduces frictional resistance to flow, which can result in higher velocities in a watercourse, potentially leading to downstream erosion or additional flooding.

Fishery Resources

As mentioned in Section 12.3.1, certain obstructions in a channel, such as logs or boulders, can cause bank instability but may also provide fish habitat. Therefore, N.J.A.C. 7:13-11.5(c)2 specifies that logs and boulders be left in the channel unless the Department determines that their removal is necessary. N.J.A.C. 7:13-11.5(c)3 requires that a stabilization effort must also avoid disrupting any existing low flow aquatic passage.



CERTAIN OBSTRUCTIONS IN A CHANNEL CAN CAUSE BANK INSTABILITY BUT MAY ALSO PROVIDE FISH HABITAT.

12.6 Application Requirements

Section 3.3 of this manual provides a general explanation of the application requirements for a permit or authorization under the FHACA Rules. However, with respect to a proposed bank stabilization or channel restoration project, the specific requirements for the following are explained below:

1. **The environmental report**
2. **The engineering report**
3. **The engineering drawings**
4. **Photographs of the watercourse and overbank areas**

The environmental report must demonstrate compliance with all of the following:

N.J.A.C. 7:13-11.1	Standards for in-channel work
N.J.A.C. 7:13-11.2	Standards for disturbance within the riparian zone for both the stabilization activities and access to the watercourse
N.J.A.C. 7:13-11.5	Standards for impacts to fishery resources
N.J.A.C. 7:13-11.6	Standards for impacts to both present or documented habitat for threatened and endangered species

See Section 12.5 for a discussion of some these individual permit standards. The environmental report must discuss how all disturbances have been minimized for the proposed project and its construction and how all temporarily disturbed areas will be restored upon completion of construction. The report must also explain how the project schedule will accommodate any applicable timing restrictions. For more information regarding environmental reports, see Section 3.3.3 of this manual.

The engineering report (discussed in Section 3.3.2) must be signed and sealed and must demonstrate compliance with all of the following:

N.J.A.C. 7:13-11.3	Standards for floodway fill

N.J.A.C. 7:13-11.4	Standards for flood storage displacement
N.J.A.C. 7:13-12.3	Standards for excavation and filling activities
N.J.A.C. 7:13-12.14	Standards for the design and construction of bank stabilization activities

The engineering report must discuss the history of both the site and the watershed. In addition, it must include the designer's qualifications in fluvial geomorphology and soil bioengineering, as required by N.J.A.C. 7:13-12.14(b)2. Some of the reasons for this requirement are explained in Section 12.2 and Section 12.3.2. The designer should supply a description of previously designed projects, focusing on the geomorphologic principles employed and the ultimate success of those projects. The engineering report must also explain how and why the geomorphologist determined that the proposed method of stabilization was the most appropriate (see Section 12.3). Signed and sealed hydrologic and hydraulic calculations must be submitted as justification.

Since the Department has established a hierarchy of preferred stabilization methods with hard armoring as the least preferable option, as discussed in Section 12.3.3, an applicant proposing hard armoring must demonstrate in the engineering report that it is the only method that will suffice. First, this demonstration typically involves calculations of velocity and shear pressure exerted at the bank, which should be based on bankfull discharge as explained in Section 12.3.2. As mentioned, bankfull discharge may be calculated with any of the standard hydrologic calculation methodologies used to calculate any other flow rate (see Section 4.5 of this manual). Once the bankfull discharge is known, the velocity in the watercourse and the watercourse power can be calculated. If an applicant wishes to utilize a different method of demonstration, they should contact the Department prior to submitting an application.

If the velocity and pressure do not exceed published threshold values for the viability of vegetative stabilization or soil bioengineering, the use of hard armoring may not be permitted without a compelling reason. However, if the numbers do exceed the threshold values, the engineering report must then show that watercourse velocity and power cannot feasibly be reduced to complete the demonstration that hard armoring is the most appropriate stabilization method. Similarly, if calculated values show that vegetation alone is insufficient but soil bioengineering is feasible, the engineering report must consider all actions that may reduce those values so that vegetative stabilization is feasible. The engineering report must include sizing calculations for the proposed stabilization measure regardless of whether soil bioengineering or hard armoring is proposed.

In addition to environmental and engineering reports, signed and sealed engineering drawings must be submitted with all applications for bank stabilization and channel restoration projects. These drawings must show:

- ✓ **The entire length of the watercourse proposed to be stabilized**
- ✓ **The limits of the riparian zone**
- ✓ **The stabilization measure with the associated area of proposed riparian zone disturbance shaded and quantified**
- ✓ **The proposed access to the site with the associated area of riparian zone disturbance shaded and quantified**
- ✓ **Cross section locations at representative intervals on the plan view**
- ✓ **Scaled cross sections showing existing and proposed channel geometry**

Please note that all cross sections must be shown at a true (not reduced) and legible scale. The Department recommends a horizontal scale of 1 inch = 10 feet and a vertical scale of 1 inch = 1 foot to ensure visibility of existing and proposed channel and bank geometry. All stabilization measures must also be shown on these cross sections to ensure that the proposed measures do not constitute fill in the floodway. Also note that the typical details of proposed stabilization measures may be included on the drawings for reference, but a scaled version of the actual measure must be included at each cross section.

Lastly, photographs of the watercourse and overbank areas must be submitted with the application. The photographs must be taken at every cross section and must clearly show the unstable condition. They must be numbered and mounted on 8.5” by 11” paper. A photograph location plan that shows the locations and direction of each photograph must accompany the photographs.

SECTION 13
STREAM CLEANING

A channel's geometry and its attendant geomorphic features are usually the result of interactions between stream flow, sediment transport, the character of the bed and bank material, and vegetation. Over time, streams and rivers naturally develop their own channel shape, dimensions, slope, and meanders as a direct result of the sediment and water inputs and the characteristics of the sediments forming the bed and banks. The gross form of a river and its floodplain are shaped by larger, less frequent discharges and modified by local geology and watershed characteristics. However, the creation and maintenance of channel dimensions and smaller-scale features, such as bars, riffles, pools, and islands (habitat features), are most closely related to more frequent discharges. Self-formed channels also adjust their conveyance capacity so that flow inundates the surrounding floodplain every one to two years on average. Streams in which the channel geometry and capacity are adjusted in this way are said to be in dynamic equilibrium. The concept of morphological adjustment towards dynamic equilibrium is fundamental to the theory and management of stream corridor processes.

As discussed in Section 12, when a stream naturally exists in a state of dynamic equilibrium, the conveyance capacity of the stream will be such that the stream is neither aggrading (accumulating material) nor degrading (losing material due to erosion) and that any channel bed and bank material that is eroded in one location will be replaced with natural material transported by the stream. In other words, the conveyance capacity of the stream is sufficient to transport enough sediment through the system to allow for the stream to maintain its channel geometry.

Most streams do not exist in equilibrium. As a result, channel geometries of streams are continually changing and reshaping. This dynamic of reforming geometric features can result in observed erosion and/or aggradation. Aggradation tends to occur when the channel geometry is larger than necessary to pass normal flows and more frequent discharges, such as the 1-year or 2-year floods. When this occurs, the velocity within the channel is not fast enough to continue to transport suspended sediments, and as result, the sediment drops out of suspension and falls into the channel. Uninterrupted, the sediment will accumulate to a point where new channel geometry forms.

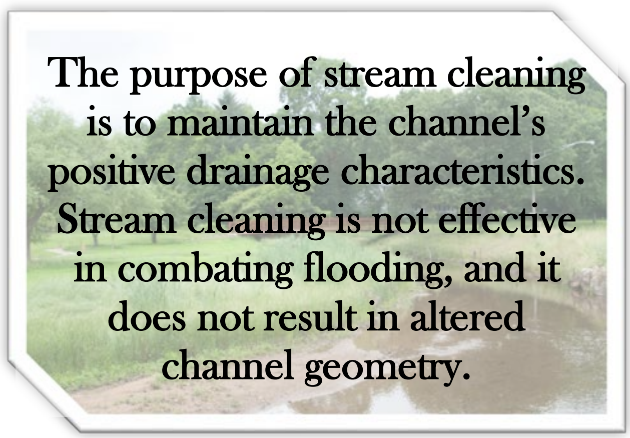
When addressing the cause of an aggradation problem (see Section 12.3.1) is not practical, the FHACA Rules allow for the removal of sediment and debris (stream cleaning) from regulated waters in certain circumstances. Section 13.1 explains the distinction between stream cleaning activities and channel modifications, which are often confused. Section 13.2 describes how to determine if a channel is aggrading. Section 13.3 discusses the types of authorizations and permits available for stream cleaning activities under the FHACA Rules while Section 13.4 explains some of the individual permit standards. Lastly, Section 13.5 provides a list of the information that is typically required for an application for a stream cleaning authorization or permit.

13.1 Stream Cleaning vs. Channel Modification

Stream cleaning involves at least one of the following activities:

- Removing unconsolidated silt and sediment to temporarily address an aggradation problem, as previously mentioned
- Removing debris from a channel

The purpose of stream cleaning is to maintain the channel's positive drainage characteristics. Stream cleaning is not effective in combating flooding, and it does not result in altered channel geometry (i.e., a deeper bed, wider banks, or a deeper channel slope).



If work in a stream does result in an alteration of channel geometry, it is no longer considered stream cleaning. Instead, it is considered a channel modification, which is defined by the FHACA Rules as "the reconfiguration or reconstruction of all or part of a channel, such as by straightening, relocating, lining, or excavating the channel, or by enclosing the channel within a structure such as a pipe or culvert." The removal of vegetation that has established itself on accumulated sediment is also considered a channel modification because it will alter the character of the stream corridor and may impact stream hydraulics. Unlike stream cleaning, channel modifications usually address flooding problems in a stream corridor.

Stream cleaning is permissible under the FHACA Rules. However, a channel modification is prohibited by the FHACA Rules in all but extreme cases. A channel modification may only be acceptable where:

- Flooding or erosion is so severe that it cannot be addressed by other means.

- A modification serves to restore a lost or degraded environmental function to a stream corridor.

When stream cleaning is intended, an applicant must delineate the limits of the natural channel bed and banks and the extent of accumulated sediment to avoid performing a prohibited channel modification instead.

13.2 Determining Depths of Accumulated Sediment and Natural Stream Bottom

The best way to determine if a stream is aggrading, and to determine its natural bottom, is to perform a reconnaissance survey consisting of a combination of fieldwork and the examination of existing data, which may include some combination of the following:

- A bathymetric survey
- Borings or probes
- An examination of in-channel features for evidence of scour or deposition
- Evidence of changes in cross-section shape and area, especially widening and shallowing of channel cross-section
- An examination of streambank heights and relationship with geomorphic bankfull indicators (for which a fluvial geomorphologist would be helpful)
- An analysis of bridge as-built conditions with current conditions
- A review of bridge maintenance records

Performing this type of work will help an applicant determine the degree of aggradation, which will inform how much sediment may be removed without altering channel geometry.

13.3 Available Permits and Authorizations

A variety of authorizations and permits are available for stream cleaning activities under the FHACA Rules. Section 3.1 of this manual provides more information about the different types of permits and authorizations.

Depending on the size and scope of the project, and the entity performing the work, stream cleaning may qualify for one of the authorizations under a permit-by-rule, general permit-by-certification, or general permit listed below. If the project does not qualify for one of these authorizations, an individual permit is required. The individual permit standards are explained in Section 13.4.

Permits-by-Rule

- Permit-by-rule 5 - removal of accumulated sediment and debris from a regulated water by hand
- Permit-by-rule 6 - removal of major obstructions (those that are too large to be removed by hand) from a regulated water with machinery

General Permits-by-Certification

- General permit-by-certification 1 - removal of accumulated sediment and debris from a regulated water for agricultural purposes
- General permit-by-certification 7 - removal of accumulated sediment and debris from an engineered channel (which is a channel that is fully lined with concrete or other armoring and/or that has been constructed, altered, or otherwise manipulated as part of a flood control project)
- General permit-by-certification 9 - sediment and debris removal within and/or adjacent to a bridge, culvert, or outfall by a public entity
- General permit-by-certification 11 – maintenance of existing manmade stormwater management structures and conveyances (which typically include stormwater detention basins, infiltration basins, bioretention basins, and wet ponds)

General Permits

- General permit 1 - channel cleaning under the Stream Cleaning Act at N.J.S.A. 58:16A-67
- General permit 2 - mosquito control water management activities

13.4 Individual Permit Standards

The requirements for an individual permit for stream cleaning activities can be found in the FHACA Rules at N.J.A.C. 7:13-12.15. To obtain an individual permit for stream cleaning, the applicant must demonstrate that there is a documented history of flooding, a mosquito control problem, or another threat to public health, safety, or welfare that necessitates the removal of sediment and/or debris from the regulated water.

To minimize the downstream transport of sediment during dredging, all areas being dredged must be isolated from flowing water where possible. One means of isolation includes erecting temporary berms or sheet-piles around the areas being dredged. For linear regulated waters, such as streams or rivers, isolation can be achieved by pumping flow around the work area or if flow within the regulated water is low, blocking off the areas being dredged and allowing the sediment to settle. For impounded regulated waters, sediment transport can be reduced by lowering the water level, plugging the downstream discharge of the water, and/or pumping the incoming water around the impoundment.

Prior to any sediment removal, the Department recommends a thorough review of potentially toxic sediment in or near the streambed where sediment removal activities are proposed or where bed sediments may be disturbed by the operations (including upstream and downstream adjacent banks and floodplain). All material removed from a channel must be disposed of outside of any regulated area (flood hazard area or riparian zone) in accordance with all applicable Federal, State, and local requirements.

Limitations also apply to the following:

- The location, type, and area of riparian zone vegetation that can be disturbed to access the regulated water (see N.J.A.C. 7:13-11.2)
- The extent to which machinery can be used in a channel (see N.J.A.C. 7:13-11.1)

Finally, it is important to note that limitations may also apply during certain periods of the year when stream cleaning activities could adversely impact the life cycle of aquatic species. For example, activities within a stream that is classified as trout production may be limited during certain months when trout are spawning. See Table 11.5 at N.J.A.C. 7:13-11.5 for the restricted time periods for regulated waters with fishery resources.

13.5 Application Requirements

The following materials are required as part of an application for stream cleaning:

1. A Topographic Survey, including all of the following information:
   - ✓ Reference datum of NGVD 1929 or NAVD 1988
   - ✓ Date and time of survey data
   - ✓ North arrow
   - ✓ Top of streambank
   - ✓ Direction of stream flow
2. A Proposed Conditions Plan, including all of the following information:
   - ✓ Reference datum of NGVD 1929 or NAVD 1988
   - ✓ North arrow
   - ✓ Top of streambank
   - ✓ Direction of stream flow
   - ✓ Access points (clearly illustrated)
   - ✓ Cross-section locations
   - ✓ Location of deposition
3. A Riparian Zone Disturbance Plan
4. Cross-sections, showing all of the following:
   - ✓ Multiple ground points to accurately define the channel bottom and the shape of the banks
   - ✓ The water surface elevation at the time of the survey
   - ✓ Notes of any changes in vegetative cover (e.g., from grass to brush)
   - ✓ Proposed sediment removal
5. A stream profile for the reach of regulated water from which sediment and debris is to be removed
6. Photographs of proposed access points to the regulated water
7. Photographs of specific areas where sediment and debris will be excavated

SECTION 14 STORMWATER MANAGEMENT

Stormwater management facilities, including basins and outfalls, help prevent flooding, especially flash flooding, along New Jersey's watercourses. A *stormwater basin* is a structure used to detain and treat stormwater runoff. *Stormwater outfalls* transfer water during storm events into stormwater basins and/or subsurface drainage systems.

Stormwater basins and outfalls are generally required as part of larger residential or commercial projects that meet the definition of a major development under the Stormwater Management Rules at N.J.A.C. 7:8. A *major development* is defined as any project that results in either the net addition of at least 0.25 acres of impervious surface or the disturbance of at least one acre of land. Refer to N.J.A.C. 7:8 and to the Frequently Asked Questions posted on www.njstormwater.org for additional guidance concerning how major developments are determined.

When a proposed project is a major development, a flood hazard area individual permit may not be issued until that project is compliant with N.J.A.C. 7:8, irrespective of how much of the project is located within the jurisdictional limits of the FHACA Rules. Please note that permits-by-rule, general permits-by-certification, and general permits may not be used for projects qualifying as major development.

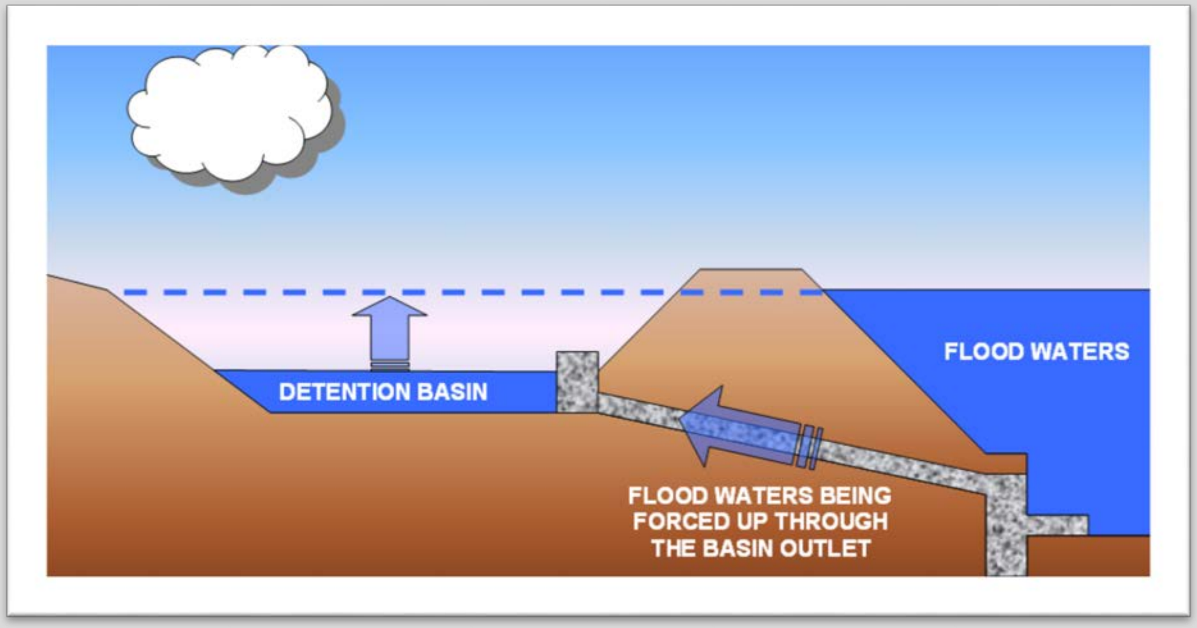
Guidance regarding the design of stormwater management facilities is available through the *New Jersey Stormwater Best Management Practices Manual*, which is available for download on the aforementioned website. Further guidance regarding stormwater basins within the flood hazard area can be found in Section 14.1 of this manual. Section 14.2 discusses requirements for stormwater discharges while Section 14.3 discusses standards for outfall design. Section 14.4 explains the standards for the stormwater management report that must be submitted to the Department for all major developments.

14.1 Stormwater Basins within the Flood Hazard Area

Ideally, stormwater management basins and their outlet pipes should be located outside the flood hazard area (see Section 4 for more information on flood hazard areas). However, due to limited space for development and other constraints, stormwater management basins are often located within the flood hazard area. In such cases, the impacts of flooding of the receiving watercourse on the basins and outlet pipes must be considered during design.

A stormwater management basin is generally designed to retain or detain certain volumes of stormwater and/or to discharge stormwater at a particular rate. Typically, basin outlet structures are designed assuming free flow at the outlet, which means that the full basin volume is available for storage. Stage-storage-discharge tables would reflect that circumstance. However, when a basin and/or its outlet pipe are placed below the flood hazard area design flood elevation (see Figure 14.1 below), the basin may function differently in a flood condition than it would in a normal flow condition. This means that there may not always be a free-flowing outlet. If the basin design is not modified to account for this, the basin may not be able to discharge its design volume as intended and therefore would not satisfy the requirements of the Stormwater Management Rules.

Figure 14.1: Basin Failure Due to Tailwater



When a stormwater management basin or its outlet pipe is constructed below the flood hazard area design flood elevation, the design must consider the functionality of the basin during both flood and non-flood events. During flood events, the rate of discharge from the basin may be significantly reduced by the tailwater conditions of the receiving water. *Tailwater conditions* refer to the water surface elevations found at the basin discharge during different flood events. Once the tailwater elevation is known, the stage-storage-discharge table used in the design of the basin can be adjusted accordingly. This will enable the applicant to ensure that the basin can function as designed during flooded conditions.

While this change in the stage-storage-discharge table addresses the maximum storage needed to ensure the basin functions as designed, there will be occasions when the receiving water body will not be at the peak elevation and the increased storage will not be utilized. Under this scenario, since the elevation of the receiving water at the outlet does not inhibit the flow rates through the outlet structure, the discharge for each stage will generally be higher than when flooding controls the outflow. Therefore, the design engineer must also demonstrate compliance with the required peak rates of runoff assuming no tailwater condition to ensure the stormwater management criteria are also met during non-flood events.

However, in some cases a basin may not be impacted by the elevation of the receiving watercourse. Due to the short travel time of runoff generated onsite compared to that of the oncoming flood, the basin may fill and discharge its design volume prior to the onset of the coming flood. In this case, flooding of the receiving watercourse would not result in a loss of available basin storage. As a result, no design modifications would be necessary. The design engineer should consider whether this assumption is appropriate when designing the basin for the 2, 10, and 100-year storm events.

Conversely, the tailwater may be so significant that it is impossible to ensure that the basin functions as required by the Stormwater Management Rules. In such cases, the design engineer should contact the Department to discuss possible options.

Note that N.J.A.C. 7:13-12.2(c)3 requires emergency spillways to be constructed above the flood hazard area design flood elevation where feasible to prevent floodwaters from overtopping the berm and flooding the basin. The assumption of available volume is predicated on the inflow to the basin filling significantly faster than the floodwaters. However, if the basin is overtopped by the floodwaters through the emergency spillway, there will be no room inside the basin to receive and detain additional stormwater runoff from the development the basin has been constructed to serve.

14.2 Standards for Stormwater Discharges

Before constructing stormwater discharges, several factors must be considered, including riparian zone disturbance, outfall orientation, and outfall design (see Section 14.3 for a detailed discussion of outfall design).

Discharge pipes from most stormwater basins will be located at or near the bank of the receiving watercourse. Therefore, constructing the outfall pipe and its associated conduit outlet protection may cause disturbance to riparian zone vegetation (see Section 6 of this manual for more information on the riparian zone). Under the FHACA Rules, such disturbance must be justified prior to construction. In other words, if the discharge pipe and its outfall structure can be situated outside of the riparian zone without causing erosion, disturbance of vegetation within the riparian zone cannot be authorized under a permit, regardless of the width of the riparian zone. It is important to note that when a discharge pipe or outfall structure must be located within a 300-foot riparian zone, 95 percent total suspended solids (TSS) removal is required prior to discharge.

In addition to considering the riparian zone when proposing stormwater outfalls, the designer must also ensure that no outfall structure or emergency spillway is oriented toward lands not owned by the applicant unless written permission is obtained from the affected property owners. Orienting outfalls or emergency spillways towards a neighboring property could adversely impact that property, which is prohibited under the FHACA Rules (see N.J.A.C. 7:13-12.1(g)2).

Stormwater discharges must also comply with any other requirements that may be imposed at the Federal, State and/or local levels, including the Standards for Soil Erosion and Sediment Control.

14.3 Outfall Design

If a stormwater outfall is not properly designed and constructed, it has the potential to focus large volumes of water collected from surface runoff into a waterway, resulting in erosion and water quality degradation as well as structural undermining. Therefore, the FHACA Rules require outfalls be designed to maximize long-term stability at the site of the outfall while minimizing disturbance to the surrounding environment. The specific design and construction standards for stormwater outfalls are located at N.J.A.C. 7:13-12.9.

Outfall design does not simply include constructing an end point for stormwater; the entire stormwater system must be considered. Usually, the pitch or slope for pipes leading to an outfall must be at least the minimum necessary to achieve scour velocity, which is the velocity needed to dislodge solids from the water. Pipe pitch becomes problematic, however, when the water velocity at the headwall exceeds the ability of the receiving surface water to accept it, resulting in erosion of the opposing bank and undermining the outfall itself (see Figure 14.2 below). This occurs particularly frequently when an outfall is designed to replace an existing one where no stormwater detention is present. Therefore, the design of any stormwater discharge should seek to minimize the velocity at the exit point as well as maximize the receiving water's ability to accept the proposed velocity and volume of discharge without compromising channel integrity and water quality.

Figure 14.2: Erosion Due to Insufficient Pipe Pitch

The Department does not consider any single design to be optimal. For a given watershed, basin, or area of flow, a calculated maximum volume of water flowing at maximum velocity will yield a recommended configuration given a chosen design. It is incumbent on the applicant's engineer to choose the best design for flow and velocity that will also minimize the footprint of disturbance to the surrounding area, especially to the stream channel and embankments. Minimization will be considered during the Department's environmental review as one of the criteria necessary for approval. If alternatives to the proposed outfall offer a more natural, stable, and/or minimal footprint, these alternatives must be utilized.

The applicant is expected to work with both the Soil Conservation District and the Department on all design considerations. Each outfall must be designed to meet New Jersey's Standards for Soil Erosion and Sediment Control at N.J.A.C. 2:90 as well as the basic engineering and environmental criteria for outfall design, including velocity reduction, scour protection, vegetative stabilization solutions, impacts of long-term channel stability on outfall stability, pipe considerations, and soils.

Velocity Reduction

Velocity reduction can be achieved while maintaining adequate pipe scour by:

- **Minimizing flow via stormwater detention**
- **Minimizing pipe run length**
- **Reducing pipe slope by incorporating drop manhole structures**
- **Interrupting long pipe runs with flow/velocity reduction structures**
- **Utilizing velocity reduction structures either within the pipe layout or as part of the outfall design**

Two possible methods for reducing velocity at or close to the headwall are the use of a drop box or the use of a cascading feature (step pools created using gabions, concrete, natural rock or other material). Both structures mimic nature's velocity-reduction process of water falling into water, reducing the discharge flow rate.

Other methods for limiting velocity at the outfall terminus may be used, including the use of barrier structures to deflect water and expend energy. However, unlike stable water structures that utilize the water itself for velocity reduction, maintenance may be required. Maintenance requirements must be addressed for all structures.

Scour Protection

At the terminus of a pipe, an outfall typically incorporates scour protection in the form of a riprap apron and/or a scour hole. The Department prefers the use of scour holes since they generally result in reduced adverse impacts to the regulated water and riparian zone vegetation when compared to a riprap apron. A scour hole has the advantage of utilizing the water within the hole itself to reduce velocity, although the velocity reduction is limited. Therefore, it may be more appropriate to construct a riprap apron depending on the size of the proposed discharge and the expected flow velocity.

Vegetative Stabilization Solutions

Where applicable, alternatives to an outfall, such as a vegetated swale, should be considered. The Department, in cooperation with the Soil Conservation District, may necessitate a vegetative solution should such a design be deemed preferable. Where an outfall requires hard armoring, side slopes and all other disturbed areas must be stabilized with a vegetative solution unless slope, soils, and/or other site conditions maintain an erosive condition, therefore justifying the use of hard armoring.

Any vegetative stabilization, whether alone or in tandem with hard armoring, must incorporate the use of variable vegetation root strata and the provided species recommendations.

Impacts of Long-Term Channel Stability on Outfall Stability

While waterways are dynamic in nature, an outfall structure is fixed in position. Outfall structures often fail due to geometric changes in the stream channel, resulting in the undermining of the outfall and/or embankment failure. Projects that include the construction and/or stabilization of an outfall structure must anticipate and estimate the impact of a potential stream geometric change. Therefore, applicants must first consider maximizing the distance of an outfall structure and a stream channel to minimize the potential of structural undermining and embankment failure and/or erosion.

Pipe Considerations

As mentioned in Section 12.3.1, improperly designed or implemented pipe installation may contribute to bank instability and failure, including through the following means:

- The creation of surface erosional channels in associated land (see Figure 14.3 on the next page)
- Outfall failure resulting in an erosional ravine
- Pipe leakage resulting in an erosional ravine, pipe failure, and possible embankment failure

For these reasons, pipe trenches should include anti-seep collars to prevent the excavation from turning into a *French drain*, meaning it could potentially drain groundwater or any surrounding wetlands. Also, outfall structures and the pipe leading to the outfall must be designed to prevent the flow of water outside of the pipe. The pipe itself must be sealed to prevent water leaking from the pipe and destabilizing the pipe and outfall.

Figure 14.3: Surface Erosional Channel Resulting from an Improperly Designed Stormwater Pipe

Soils

A proper analysis of soils must be conducted at the construction site to ensure a stable base is available for the stormwater pipe, outfall structure, and any riprap apron or scour hole. This is especially important in sandy and sandy loam soils located on slopes of three percent or greater. Failure to adequately plan and design for site conditions may result in outfall failure.

14.4 Requirements for Stormwater Management Reports

A stormwater management report must be submitted for any project that qualifies as a major development, as defined by the Stormwater Management Rules at N.J.A.C. 7:8-1.2. This report must demonstrate compliance with both the FHACA Rules at N.J.A.C. 7:13-11.2 and the Stormwater Management Rules at N.J.A.C. 7:8. The report must address hydrology, low impact design, quantity, quality, recharge, and best management practices (BMP) maintenance. The report must contain a narrative summarizing compliance with the specific standards of these rules as well as supporting calculations and a completed Low Impact Development Checklist, which can be found in Appendix A of the *New Jersey Stormwater Best Management Practices Manual* at www.njstormwater.org. (See Section 4.5 and Section 4.6 of this manual for information on how to perform hydrologic and hydraulic calculations and Section 4.8 for the hydrologic and hydraulic reporting requirements.)

A STORMWATER MANAGEMENT REPORT MUST BE SUBMITTED FOR ANY PROJECT THAT QUALIFIES AS A MAJOR DEVELOPMENT, AS DEFINED BY THE STORMWATER MANAGEMENT RULES AT N.J.A.C. 7:8-1.2. THIS REPORT MUST DEMONSTRATE COMPLIANCE WITH BOTH THE FHACA RULES AT N.J.A.C. 7:13-11.2 AND THE STORMWATER MANAGEMENT RULES AT N.J.A.C. 7:8.

Additionally, the stormwater management report should contain a summary of all assumptions made during the stormwater analysis. This includes any information used to determine existing and proposed condition flow rates, including a discussion of any features on site that would serve to naturally attenuate flow rates in the existing condition. Tables should be generated to summarize all input data used to devise existing condition hydrographs. Similarly, all input data should be submitted for the proposed condition hydrographs. This includes those hydrographs that will serve as input for basin routings. Elevation-volume-discharge tables should also be submitted based on the configuration of any proposed outlet control structures.

A signed and sealed report that addresses soil conditions is also required. Stormwater BMPs must be located a certain distance above the seasonal high groundwater table. Therefore, a soils report that details the location of the seasonal high groundwater table is necessary. The seasonal high groundwater table is typically determined by the presence of mottling or through direct observation. If direct observation is used to determine the seasonal high groundwater table, such observations must be made during the wet time of the year, between January and April. Where an applicant proposes an infiltration-based BMP or seeks to determine the hydrologic soil group classification of a soil on site, the soils report must also document the permeability of the soil.

The soils report must contain data sheets (e.g., soil profiles, results of testing). Merely stating the location of the seasonal high groundwater table or the soil permeability is not sufficient. Supporting data must be submitted. Guidance for determining the location of the seasonal high groundwater table and acceptable tests used to determine the soil permeability can be found in Appendix E of the aforementioned New Jersey Stormwater Best Management Practices Manual. Please note that Appendix E includes a variety of acceptable soil permeability tests but does not include a sieve analysis. Sieve analyses are not acceptable since they do not indicate where in the soil profile the fines are located, which can lead to erroneous permeability results.

Finally, engineering drawings must be drafted to supplement the stormwater management calculations, including existing and proposed condition drainage area maps. These maps should clearly show existing and proposed runoff flow paths. An additional engineering drawing should be drafted to visually depict all proposed non-structural design strategies employed in the site design. A drawing is also needed that shows dimensioned details for each stormwater BMP proposed for the site.

APPENDIX A
PERMITS-BY-RULE BY CATEGORY

Permits-by-Rule				
General Construction Activities	7:13-7.1	Permit-by-rule 1	–	normal property maintenance
	7:13-7.2	Permit-by-rule 2	–	repair of a lawfully existing structure
	7:13-7.3	Permit-by-rule 3	–	in-kind replacement of a lawfully existing structure
	7:13-7.4	Permit-by-rule 4	–	removal of any lawfully existing structure
	7:13-7.5	Permit-by-rule 5	–	removal of accumulated sediment and debris from a regulated water by hand
	7:13-7.6	Permit-by-rule 6	–	removal of major obstructions from a regulated water with machinery
	7:13-7.7	Permit-by-rule 7	–	placement of no more than five cubic yards of landscaping material
	7:13-7.8	Permit-by-rule 8	–	construction at or below grade in a fluvial flood hazard area
	7:13-7.9	Permit-by-rule 9	–	general construction activities in a tidal flood hazard area
	7:13-7.10	Permit-by-rule 10	–	general construction activities located outside a flood hazard area in a riparian zone
Buildings	7:13-7.11	Permit-by-rule 11	–	reconstruction, relocation, and/or elevation of a lawfully existing building
	7:13-7.12	Permit-by-rule 12	–	construction of an addition(s) to a lawfully existing habitable building
	7:13-7.13	Permit-by-rule 13	–	construction of a non-habitable building(s)
	7:13-7.14	Permit-by-rule 14	–	construction of a partially-open structure(s)
	7:13-7.15	Permit-by-rule 15	–	construction of barrier-free access to a building
	7:13-7.16	Permit-by-rule 16	–	construction of a deck
Water Dependent	7:13-7.17	Permit-by-rule 17	–	construction of a dock, pier, or boathouse
	7:13-7.18	Permit-by-rule 18	–	construction of a boat launching ramp
	7:13-7.19	Permit-by-rule 19	–	replacement, renovation, or reconstruction of certain water dependent structures

Specific Construction	7:13-7.20	Permit-by-rule 20 –	construction of a fence
	7:13-7.21	Permit-by-rule 21 –	construction of a swimming pool associated with residential use
	7:13-7.22	Permit-by-rule 22 –	construction of a trail and/or boardwalk
	7:13-7.23	Permit-by-rule 23 –	construction of a footbridge
	7:13-7.24	Permit-by-rule 24 –	construction of a tank
	7:13-7.25	Permit-by-rule 25 –	construction of an aboveground athletic and/or recreational structure
	7:13-7.26	Permit-by-rule 26 –	forest management activities
	7:13-7.27	Permit-by-rule 27 –	repair, maintenance, and/or dredging of a manmade canal
	7:13-7.28	Permit-by-rule 28 –	filling of an abandoned raceway
	7:13-7.29	Permit-by-rule 29 –	placement of one to three wind turbines
	7:13-7.30	Permit-by-rule 30 –	placement of solar panels and associated equipment
	7:13-7.31	Permit-by-rule 31 –	placement of a floating aerator
	7:13-7.32	Permit-by-rule 32 –	construction of an aquatice habitat enhancement device
Utilities	7:13-7.33	Permit-by-rule 33 –	placement of one or more utility poles
	7:13-7.34	Permit-by-rule 34 –	placement of one or more utility open-frame towers
	7:13-7.35	Permit-by-rule 35 –	placement of one or more utility monopole towers
	7:13-7.36	Permit-by-rule 36 –	placement of an underground utility line using directional drilling or jacking
	7:13-7.37	Permit-by-rule 37 –	placement of an underground utility line beneath existing pavement
	7:13-7.38	Permit-by-rule 38 –	attachment of a utility line to a lawfully existing roadway or railroad that crosses a regulated water
	7:13-7.39	Permit-by-rule 39 –	placement of an underground utility line that does not cross a regulated water
Roads	7:13-7.40	Permit-by-rule 40 –	milling, repaving, and/or resurfacing of a lawfully existing pavement
	7:13-7.41	Permit-by-rule 41 –	placement of a guiderail along a lawfully existing public roadway
	7:13-7.42	Permit-by-rule 42 –	reconstruction of all or part of a lawfully existing bridge superstructure
	7:13-7.43	Permit-by-rule 43 –	placement of traffic safety structures on poles
Surveying	7:13-7.44	Permit-by-rule 44 –	surveying activities
	7:13-7.45	Permit-by-rule 45 –	geotechnical and archeological investigation activities
	7:13-7.46	Permit-by-rule 46 –	installation of one or more monitoring wells
	7:13-7.47	Permit-by-rule 47 –	construction of a gauge, weir, or similar device

Storage	7:13-7.48	Permit-by-rule 48 –	temporary storage of unsecured construction material outside a floodway
	7:13-7.49	Permit-by-rule 49 –	storage of unsecured material associated with a single-family home or duplex
	7:13-7.50	Permit-by-rule 50 –	storage of unsecured material associated with a habitable building or facility, other than a single-family home or duplex
	7:13-7.51	Permit-by-rule 51 –	storage of unsecured material associated with a facility that stores and distributes material
	7:13-7.52	Permit-by-rule 52 –	placement, storage, or processing of hazardous substances
	7:13-7.53	Permit-by-rule 53 –	placement, storage, or processing solid waste or recyclable materials at a lawfully existing facility
Agricultural Activities	7:13-7.54	Permit-by-rule 54 –	continutation of lawfully existing agricultural activities
	7:13-7.55	Permit-by-rule 55 –	commencement of new agricultural activities
	7:13-7.56	Permit-by-rule 56 –	continuation or commencement of natural resource conservation practices associated with agricultural activities
	7:13-7.57	Permit-by-rule 57 –	construction of a non-habitable building for agricultural purposes
	7:13-7.58	Permit-by-rule 58 –	filling or modification of a manmade regulated water for freshwater wetlands restoration
	7:13-7.59	Permit-by-rule 59 –	creation of a ford across a regulated water to manage livestock
	7:13-7.60	Permit-by-rule 60 –	construction of a fence along and/or across a regulated water to manage livestock
	7:13-7.61	Permit-by-rule 61 –	construction of a pump and/or water intake structure in or along a regulated water for livestock
	7:13-7.62	Permit-by-rule 62 –	constuction of a manure management structure for livestock or horses
Other Activities	7:13-7.63	Permit-by-rule 63 –	application of herbicide within riparian zones to control invasive plant species

APPENDIX B
GENERAL PERMITS-BY-CERTIFICATION BY CATEGORY

General Permits-by-Certification			
Agricultural Activities	7:13-8.1	General permit-by-certification 1 –	removal of accumulated sediment and debris from a regulated water for agricultural purposes
	7:13-8.2	General permit-by-certification 2 –	construction of an agricultural roadway crossing
	7:13-8.3	General permit-by-certification 3 –	agricultural bank stabilization and/or bank restoration activities
Environmental Enhancement	7:13-8.4	General permit-by-certification 4 –	enhancement of a riparian zone through the planting of native, non-invasive plant species
Buildings	7:13-8.5	General permit-by-certification 5 –	reconstruction, relocation, expansion, and/or elevation of a building outside a floodway
	7:13-8.6	General permit-by-certification 6 –	construction of one single-family home or duplex in a tidal flood hazard area
	7:13-8.8	General permit-by-certification 8 –	construction of an addition to a lawfully existing building
Sediment Removal	7:13-8.7	General permit-by-certification 7 –	removal of accumulated sediment and debris from an engineered channel
	7:13-8.9	General permit-by-certification 9 –	sediment and debris removal within and/or adjacent to a bridge, culvert, or outfall by a public entity
Maintenance and Replacement Activities	7:13-8.10	General permit-by-certification 10 –	in-kind replacement of a culvert
	7:13-8.11	General permit-by-certification 11 –	maintenance of existing manmade stormwater management structures and conveyances
	7:13-8.15	General permit-by-certification 15 –	in-kind replacement of public infrastructure
Surveying or Water Monitoring	7:13-8.12	General permit-by-certification 12 –	surveying and geotechnical and archaeological investigation activities
	7:13-8.14	General permit-by-certification 14 –	placement of water monitoring devices

Alternative Energy	7:13-8.13 General permit-by-certification 13 – placement of solar panels
Trails and Footbridges	7:13-8.16 General permit-by-certification 16 – construction of a footbridge

APPENDIX C
GENERAL PERMITS BY CATEGORY

General Permits			
In-Stream Activities	7:13-9.1	General permit 1 –	channel cleaning under the Stream Cleaning Act
	7:13-9.2	General permit 2 –	mosquito control water management activities
Bridges and Roads	7:13-9.3	General permit 3 –	scour protection activities at bridges and culverts
	7:13-9.7	General permit 7 –	relocation of manmade roadside ditches to faciliate public roadway improvements
	7:13-9.9	General permit 9 –	construction or reconstruction of a bridge or culvert across a regulated water with a drainage area of less than 50 acres
	7:13-9.10	General permit 10 –	reconstruction of a bridge or culvert across a regulated water with a drainage area of 50 acres or more
Buildings	7:13-9.5	General permit 5 –	reconstruction and/or elevation of a building in a floodway
	7:13-9.6	General permit 6 –	construction of one single-family home or duplex, and one associated driveway that does not cross a regulated water, in a fluvial flood hazard area
Trails and Footbridges	7:13-9.12	General permit 12 –	construction of footbridges
	7:13-9.13	General permit 13 –	construction of trails and boardwalks
Other Activities	7:13-9.4	General permit 4 –	creation, restoration, and enhancement of habitat and water quality values and functions
	7:13-9.8	General permit 8 –	placement of storage tanks
	7:13-9.11	General permit 11 –	for a stormwater outfall along a regulated water with a drainage area of less than 50 acres
	7:13-9.14	General permit 14 –	application of herbicide within riparian zones to control invasive plant species

APPENDIX D
SAMPLE ENGINEERING REPORT OUTLINE – INDIVIDUAL PERMITS

APPLICANT:
PROJECT:
LOT(S):
BLOCK(S):
MUNICIPALITY/MUNICIPALITIES:
COUNTY/COUNTIES:

INITIAL DATE OF REPORT:
REVISION DATE:

PROJECT INTRODUCTION:

Describe the site in the existing condition, including a summary of land cover, the number of drainage areas, and the location of drainage areas. Provide an inventory of the environmentally sensitive portions of the site (which portions of the site are located within the floodway, flood fringe, riparian zone (see Section 6 of this manual), freshwater wetlands, and transition areas and which portions of the site contain threatened or endangered species habitat (see Section 8), etc.) Provide a brief summary of the project. Include any prior Department actions on site (approvals, denials, withdrawn applications, cancelled applications, Enforcement actions), and how they impact the proposed project, if at all.

7:13-3 LIMIT OF FLOOD HAZARD AREA – FLOODWAY LIMIT AND FLOOD HAZARD AREA DESIGN FLOOD ELEVATION (SEE SECTION 4 OF THIS MANUAL)

Document the source of flood hazard information for the site. List the flood hazard elevation(s), including datum note and conversion factor. If calculations are prepared to the extent that they need to be reviewed as part of this permit, follow information required in the example report outline for a flood hazard area verification (see Appendix E of this manual).

7:13-11.1 REQUIREMENTS FOR A REGULATED ACTIVITY IN A CHANNEL

If regulated activities are located in a channel, include a summary of project compliance with this section of the rules.

7:13-11.3 Requirements for a regulated activity in a floodway

If regulated activities are located within a floodway, include a summary of project compliance with this section of the rules. Describe how proposed activities in the floodway are allowed pursuant to this section of the rules.

7:13-11.4 Requirements for a regulated activity in a flood fringe

If regulated activities are located within a flood fringe, include a summary of project compliance with this section of the rules. Discuss how placement of fill has been minimized. Provide calculations and summary tables depicting existing and proposed flood storage volumes, where required (see Section 5 of this manual). Compare the existing storage volumes with historic benchmarks (1977, 2004, 2007, as required). Calculations may be attached as an appendix to this document. Where calculations are not required, provide a justification for the contention.

7:13-12.1 Requirements that apply to all regulated activities

Include a summary of project compliance with this section of the rules. Describe all soil erosion measures to be utilized. Also, where applicable, describe how the proposed project will not result in adverse offsite impacts in any of the required storm events described in this section of the rules.

7:13-12.2 & 7:8 Requirements for stormwater management*** (see Section 14 of this manual)

*Quantify the net increase in impervious coverage and the overall proposed land disturbance. If the proposed project is a major development, include a stormwater management report*** that addresses N.J.A.C. 7:8. Describe the impact of tailwater on the stormwater management design.*

<u>*C1 Consideration:</u>**

Note that if the project contains an outfall structure located within a 300-foot riparian zone and there will be any amount of runoff discharged from the site during the water quality storm, 95 percent TSS removal is required pursuant to N.J.A.C. 7:13-11.2(j), irrespective of the amount of impervious coverage added to or removed from the site. Provide calculations for proposed water quality measures. Calculations may be included as an appendix to this document.

<u>Nonstructural Design:</u>

Provide a discussion of which nonstructural design elements were utilized in the stormwater management design. Provide justification as to how the inclusion of these elements was maximized. Where certain elements were not employed, provide justification. This justification must include a discussion of what possible project revisions could better maximize the use of nonstructural strategies <u>and</u> why those revisions were not incorporated into the proposed design. <u>Do not submit</u> the NSPS spreadsheet.

Quality:

*Provide a summary of the selected stormwater management facilities proposed to provide water quality. In so doing, quantify the net increase in impervious coverage on site. List the required amount of treatment (X acres to Y% TSS removal) and the proposed amount of treatment (XX acres to YY% TSS removal). Submit all design calculations and drainage area mapping. *Calculations and mapping may be included as an appendix to this document.*

Quantity:

*Provide a summary of how the selected stormwater management facilities provide the required amount of peak flow rate attenuation. Include summary tables for existing, proposed, and allowed peak flow rates. Where attenuation is not required, provide justification for the contention. Submit all design calculations and drainage area mapping. *Calculations and mapping may be included as an appendix to this document.*

Recharge:

*Quantify the recharge deficit, and provide a summary of what stormwater management facilities compensate for the deficit. Submit all design calculations and drainage area mapping. *Calculations and mapping may be included as an appendix to this document.*

Soil Permeability/Testing Methods Utilized:

Describe the testing method used to determine soil permeability. Describe at what location in the soil profile the permeability testing was performed. Discussion needs to demonstrate compliance with Appendix E of the New Jersey Stormwater Best Management Practices Manual.

Elevation of Seasonal High Groundwater Table/Methodology Utilized:

Describe the testing method used to determine the elevation of the seasonal high groundwater table. Discussion needs to demonstrate compliance with the New Jersey Stormwater Best Management Practices Manual and N.J.A.C. 7:9A-5.8.

7:13-12.3 Requirements for Excavation, Fill and Grading Activities

Where such activities are proposed, include a summary of project compliance with this section of the rules.

7:13-12.4 Requirements for a Structure

Describe how proposed structures resist impact, uplift, floatation, collapse, displacement, overturning, sliding pressure, and undermining. Submit calculations as required. Calculations may be submitted as an appendix to this document.

7:13-12.5 Requirements for a Building (see Section 9 of this Manual)

Explain whether the proposed buildings are habitable or non-habitable. Describe each building according to use (single family, multi-residence, critical, etc.) and according to flood design classification (1 through 4). Explain whether each building is at least partially located *within a coastal A or V zone. Document if proposed work constitutes a substantial improvement. Demonstrate how the proposed buildings have at least one roadway situated at least one foot above the flood hazard area design flood elevation. Describe in detail how the proposed buildings meet the low floor requirements and comply with the [Uniform Construction Code](). Include any and all flood proofing calculations and drawing details. Calculations may be submitted as an appendix to this document.*

7:13-12.6 REQUIREMENTS FOR A RAILROAD, ROADWAY OR PARKING AREA

Specify the elevation of the travel surface of any proposed new or reconstructed railroad, roadway, or parking area. Where such surfaces are situated below the required elevation, describe all measures taken to elevate them to the extent feasible. Describe how the low elevations pose no extraordinary risk to the public using these areas.

7:13-12.7 REQUIREMENTS FOR A BRIDGE OR CULVERT (SEE SECTION 10 OF THIS MANUAL)

Summarize the existing and proposed structures (bridge length, span, low chord elevation, high chord elevation, headwall orientation, skew angle, parapet dimensions, type of material of which the structure is comprised). If the proposed structure is not three-sided with a natural bottom, justify selection of the type of structure proposed. Specify whether a fragmentation issue exists. Specify the measures taken to resolve or prevent a fragmentation issue in the proposed condition.

*Summarize hydraulic impacts of the proposed structure by creating a table of existing vs. proposed water surface elevations for each storm event analyzed. Summarize all assumptions made in each of the hydrologic and hydraulic models submitted for review. Explain how any warning messages encountered by these models do not invalidate the results of the models. Submit the hydrologic and hydraulic calculations and drainage area mapping for review. *Calculations and mapping may be included as an appendix to this document.*

7:13-12.8 REQUIREMENTS FOR A UTILITY LINE (SEE SECTION 11 OF THIS MANUAL)

Describe the method of installation (open trench, directional drill, etc.). Specify what substance the proposed utility line will convey, whether it will cross a watercourse, whether it will be situated aboveground or underground, how far below the watercourse bed it will be placed, whether or not it will be encased, and how any manholes will be installed.

7:13-12.9 REQUIREMENTS FOR A STORMWATER OUTFALL STRUCTURE (SEE SECTION 14 OF THIS MANUAL)

Demonstrate how a proposed outfall structure will not obstruct flow in a floodway, interfere with the normal flow of the channel, or be a source of erosion. Include calculations for all conduit outlet protection measures. Calculations may be included as an appendix to this document.

7:13-12.10 REQUIREMENTS FOR A LOW DAM

Specify the location of the proposed low dam, and provide justification if it is located within 25 feet of the top of bank of any watercourse.

7:13-12.11 REQUIREMENTS FOR A DAM

Specify the location of the proposed dam, and provide justification if it is located within 25 feet of the top of bank of any watercourse.

7:13-12.12 REQUIREMENTS FOR A FLOOD CONTROL PROJECT

Describe the extent of the flooding problem. Describe how the proposed project qualifies as a flood control project. Include an alternatives analysis discussing other solutions to the flooding problem that would avoid impacts associated with the proposed project but that were rejected by the applicant. Include reasons for rejection.

7:13-12.13 REQUIREMENTS FOR A RETAINING WALL OR BULKHEAD

Provide an engineering certification (see Section 3.3.1 of this manual) confirming that the proposed structure will have stable footings and will withstand displacement, overturning, and failure as well as erosion. Note that the certification must include supporting calculations. Calculations may be submitted as an appendix to this document.

7:13-12.14 REQUIREMENTS FOR BANK STABILIZATION AND CHANNEL RESTORATION (SEE SECTION 12 OF THIS MANUAL)

Document the instability problem as well as the history of the site, potential causes of the problem, and previously attempted measures to correct the problem. Describe, via alternatives analysis (including calculations), how the proposed stabilization or restoration measures are the most appropriate according to the hierarchy described in this section of the rules. Describe how the proposed project will not result in additional offsite flooding, using calculations where necessary. Calculations may be submitted as an appendix to this document.

7:13-12.15 REQUIREMENTS FOR SEDIMENT AND DEBRIS REMOVAL FROM A REGULATED WATER (SEE SECTION 13 OF THIS MANUAL)

Document the problem caused on site due to the presence of sediment and debris in the water. Describe how the work areas will be isolated from flowing waters and where the material will be disposed. Document how the natural stream bottom elevation was determined at each cross-section.

7:13-12.16 REQUIREMENTS FOR THE STORAGE OF UNSECURED MATERIAL

Classify the unsecured material to be stored (vehicles, landscaping materials, etc.). Describe whether other places exist outside of regulated areas where such storage can occur and why those areas were not selected for use. Describe how the unsecured material will be isolated from floodwaters and how storage won't pose a threat to the public or environment.

7:13-12.17 REQUIREMENTS FOR THE INVESTIGATION, CLEANUP, OR REMOVAL OF HAZARDOUS SUBSTANCES

Describe how the proposed project meets the Technical Requirements for Site Remediation and the Administrative Requirements for the Remediation of Contaminated Sites rules. Document that stockpiles will be located outside the floodway, contained or isolated from floodwaters, and placed above the 10-year flood elevation. Demonstrate compliance with flood storage displacement standards (see Section 5 of this manual).

7:13-12.18 REQUIREMENTS FOR THE PLACEMENT, STORAGE OR PROCESSING OF HAZARDOUS SUBSTANCES

Explain how the site already contains a lawfully existing facility. Demonstrate how hazardous materials will be kept outside the floodway and isolated from floodwaters. Demonstrate compliance with flood storage displacement standards (see Section 5 of this manual). Demonstrate how storage will not pose a threat to the public or environment.

7:13-12.19 REQUIREMENTS FOR SOLID WASTE LANDFILL CLOSURE

Explain how the proposed project complies with the Solid Waste Regulations. Include a copy of the landfill closure and post-closure plan or disruption approval issued by the Department. Describe measures taken to ensure that waste will be stabilized so as not to be eroded, displaced, or transported offsite.

7:13-12.20 REQUIREMENTS FOR THE PLACEMENT, STORAGE, OR PROCESSING OF SOLID WASTE OR RECYCLABLE MATERIALS

Explain how the site already contains a lawfully existing facility and how materials will be kept outside the floodway and be isolated from floodwaters. Explain why alternate locations outside of regulated areas cannot be utilized. Demonstrate compliance with flood storage displacement standards (see Section 5 of this manual.). Demonstrate how storage will not pose a threat to the public or environment.

7:13-12.21 REQUIREMENTS FOR THE REMOVAL OF EXISTING FILL OR AN EXISTING STRUCTURE

Demonstrate that any fill removed from a floodway will not result in additional, offsite flooding. Submit hydrologic and hydraulic calculations as necessary. Calculations may be submitted as an appendix to this document. Where calculations are not necessary, provide a basis for the contention. Describe proposed measures to stabilize the site, in the post-removal condition.

PREPARED BY OR UNDER THE SUPERVISION OF: ____________________________

Engineer of Record
(affix raised seal here)

DATE: ____________________________

**Note for calculations and mapping: All calculations must be signed and sealed. All mapping to be submitted must contain labeled contours to verify the boundaries of any drainage areas shown thereon.*

APPENDIX E
SAMPLE ENGINEERING REPORT OUTLINE – VERIFICATIONS

APPLICANT:
PROJECT:
LOT(S):
BLOCK(S):
MUNICIPALITY/MUNICIPALITIES:
COUNTY/COUNTIES:

INITIAL DATE OF REPORT:
REVISION DATE:

PROJECT INTRODUCTION:

Describe the scope of the verification – to verify the flood hazard design flood elevation, limit of the riparian zone (see Section 6 of this manual), and/or limit of the floodway on site. For sites containing multiple regulated waters, list the scope of the verification for each water separately.

7:13-3 LIMIT OF FLOOD HAZARD AREA – FLOODWAY LIMIT AND FLOOD HAZARD AREA DESIGN FLOOD ELEVATION (SEE SECTION 4 OF THIS MANUAL)

State which method was utilized to determine the flood hazard limits (Methods 1 through 6), and explain why the selected method is the most appropriate.

For Methods 1 through 3, submit copies of each flood map from which the flood elevation and/or floodway was referenced. Indicate the site location on each map. In a narrative, specify the flood hazard design flood elevation, or range thereof, within the limits of the site.

For Method 5, submit drainage area mapping (ensure that the mapping has labeled contours) as well as topography for any road crossings or other downstream obstructions relevant to the calculation. In a narrative, create a table specifying the size of the contributory drainage area, the watershed management area in which the project is located, and the depth of flooding resulting from the size of the drainage area as well as from the depth of flooding over any downstream road crossings/other obstructions. Specify the flood hazard design flood elevation, or range thereof, within the limits of the site.

For Methods 4 and 6, submit a table summarizing the hydrologic data. For NRCS methodology, include size of the contributory drainage area, time of concentration, overall CN value, unit hydrograph, rainfall distribution, antecedent moisture condition, and rainfall amounts. Include resulting peak flow rates for each storm analyzed. Provide calculations showing the derivation of input data for the time of concentration and composite CN. Provide the peak flow *rate calculations showing each piece of input data used to compute the peak flow rates. Calculations may be included as an appendix to this document.*

For Methods 4 and 6, submit a table summarizing the hydraulic data. State the type of hydraulic model used (HEC-RAS, etc.). Discuss the assumptions that went into building the model and discuss any warning messages returned by the model relative to how these messages may impact the validity of the results. Also discuss the assumptions made for any in-watercourse structures, including bridges, culverts, lateral weirs, etc. In narrative form, list the dimensions of each structure. List the flood hazard design flood elevation, or range thereof, on site. Submit model input and output, including all boundary conditions, flow regimes, cross-sectional geometry, tabular output data, and any warning messages. Where the model will graphically generate cross-sections and a watercourse profile, submit this information as well. Calculations and print outs may be submitted as an appendix to this document. Submit an electronic copy on disk of the hydraulic model.

For any encroachment analyses, submit a table summarizing the 100-year water surface elevations vs. the encroached elevations for each cross-section along with the difference between the two elevations. Submit the encroachment runs of the hydraulic model, including both input and output, and ensuring that the input indicates the encroachment method utilized (equal conveyance) as well as the target increases in water surface elevations. This may be submitted as an appendix to this document.

PREPARED BY OR UNDER THE SUPERVISION OF: __________________________

Engineer of Record
(affix raised seal here)

DATE: __________________________

APPENDIX F
SAMPLE ENVIRONMENTAL REPORT OUTLINE

APPLICANT:
PROJECT:
LOT(S):
BLOCK(S):
MUNICIPALITY/MUNICIPALITIES:
COUNTY/COUNTIES:

INITIAL DATE OF REPORT:
REVISION DATE:

PROJECT INTRODUCTION:

Describe the site in the existing condition, including a summary of existing vs. proposed land coverage. Provide an inventory of the environmentally sensitive portions of the site (which portions of the site are located within the floodway, flood fringe, riparian zone, freshwater wetlands, and transition areas and which portions of the site or nearby properties contain threatened or endangered species habitat, etc.) Provide a brief summary of the project. Include any prior Department actions on site (approvals, denials, withdrawn applications, cancelled applications, Enforcement actions), and how they impact the proposed project, if at all.

7:13-11.1 REQUIREMENTS FOR A REGULATED ACTIVITY IN A CHANNEL

If regulated activities are located in a channel bottom or within its banks, include a summary of project compliance with this section of the rules.

7:13-11.2 REQUIREMENTS FOR A REGULATED ACTIVITY IN A RIPARIAN ZONE (SEE SECTION 6 OF THIS MANUAL)

State the width of the riparian zone for each regulated water onsite. State the width of the riparian zone for any offsite waters whose riparian zones encroach onto the site. Provide documentation supporting the width of the riparian zone. This includes, but is not limited to, a current Natural Heritage Database letter with a one-mile search radius. If a water lacks a regulatory riparian zone, provide justification for the contention. Describe measures taken to determine the location of the top of bank of each regulated water on site (break in slope, change in vegetation, etc.). Also describe measures to locate the top of bank of offsite waters whose riparian zones extend onto the site in question. Describe measures taken to minimize disturbance to vegetation within the riparian zone. If any work is proposed within 25 feet of the top of bank of a regulated water, provide justification in accordance with the requirements of *this section of the rules. Create a table that lists the proposed area of disturbance to vegetation in the riparian zone vs. the allowed disturbance pursuant to Table 11.2. Note where any type of riparian zone mitigation is required, and note the amount required. Describe in detail proposed replanting plans required by N.J.A.C. 7:13-11.2(z).*

**Note that where an outfall structure is proposed within a 300-foot riparian zone, 95 percent TSS removal is required where there will be any discharge in or through the riparian zone, irrespective of whether or not the proposed project is a major development. See N.J.A.C. 7:13-11.2(j)4 for more information.*

7:13-11.5 Requirements for a regulated activity in or along a regulated water with fishery resources

If regulated activities are proposed in or along a regulated water with fishery resources, describe how the project will avoid negative impacts to aquatic habitat and their life cycles, as well as aquatic passage within the regulated waters. Also describe how the project schedule and construction sequencing will accommodate any and all imposed timing restrictions.

7:13-11.6 Requirements for a regulated activity in or affecting a present or documented habitat for threatened or endangered species (see Section 8 of this manual)

Submit a current Natural Heritage Database letter to document the presence of endangered or threatened species. Where such species exist on or in proximity to a site, describe proposed measures that will ensure that the proposed activities will not destroy, jeopardize, or adversely impact such habitat or the continued existence of that species. Include a survey or habitat assessment where applicable.

7:13-12.1 Requirements that apply to all regulated activities

Include a summary of project compliance with this section of the rules.

7:13-12.7 Requirements for a bridge or culvert (see section 10 of this manual)

Specify whether a fragmentation issue exists. Specify the measures taken to either resolve or prevent a fragmentation issue in the proposed condition. Where a proposed bridge or culvert does not completely span the regulated water, provide justification why a span was not possible. Where a proposed bridge or culvert does not feature a bottom consisting of native substrate, provide justification why it was not possible to incorporate such a bottom. Describe measures taken to provide low-flow aquatic passage.

7:13-12.8 Requirements for a utility line (see section 11 of this manual)

Describe measures taken to ensure any open trenching in a regulated water or riparian zone is no more than 20 feet in width, that any utility line is constructed at least 10 feet from the top of bank, and how normal flow is piped or otherwise diverted around any open trenching within a regulated water.

7:13-12.9 Requirements for a stormwater outfall structure (see Section 14 of this manual)

Demonstrate how a proposed outfall structure will not interfere with the normal flow of the channel or be a source of erosion.

7:13-12.12 Requirements for a Flood Control Project

Submit an alternatives analysis discussing other solutions to the flooding problem that would avoid impacts associated with the proposed project but that were rejected by the applicant. Include reasons for rejection.

7:13-12.14 Requirements for Bank Stabilization and Channel Restoration (see Section 12 of this manual)

Document the instability problem as well as the history of the site, potential causes of the problem, and previously attempted measures to correct the problem. Describe, via alternatives analysis, how the proposed stabilization or restoration measures are the most appropriate according to the hierarchy described in this section of the rules.

7:13-12.15 Requirements for Sediment and Debris Removal from a Regulated Water (see Section 13 of this manual)

Document the problem caused on site due to the presence of sediment and debris in the water. Describe how the work areas will be isolated from flowing waters and where the material will be disposed. Document how the natural stream bottom elevation was determined at each cross-section.

7:13-12.17 Requirements for the Investigation, Cleanup, or Removal of Hazardous Substances

Describe how the proposed project meets the Technical Requirements for Site Remediation and the Administrative Requirements for the Remediation of Contaminated Sites rules.

7:13-12.19 Requirements for Solid Waste Landfill Closure

Explain how the proposed project complies with the Solid Waste Regulations. Include a copy of the landfill closure and post-closure plan or disruption approval issued by the Department. Describe measures taken to ensure that waste will be stabilized so as not to be eroded, displaced, or transported offsite.

7:13-12.21 Requirements for the Removal of Existing Fill or an Existing Structure

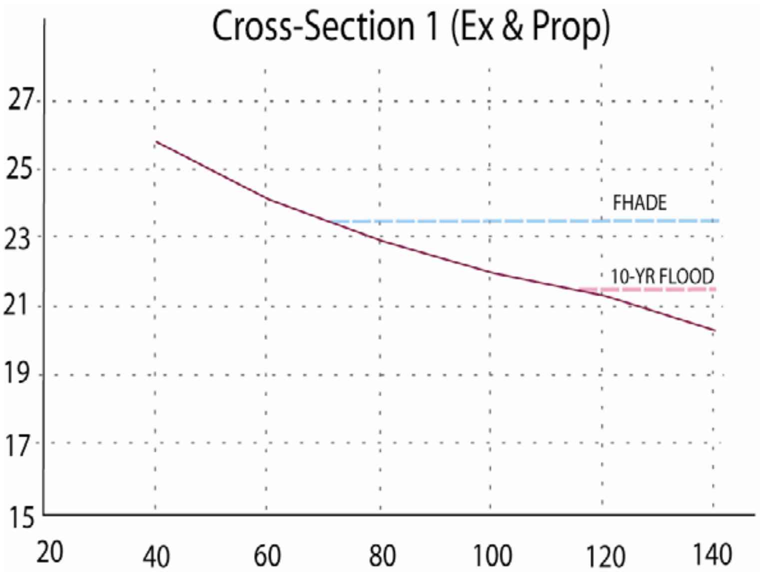
Describe proposed measures to stabilize the site in the post-removal condition.

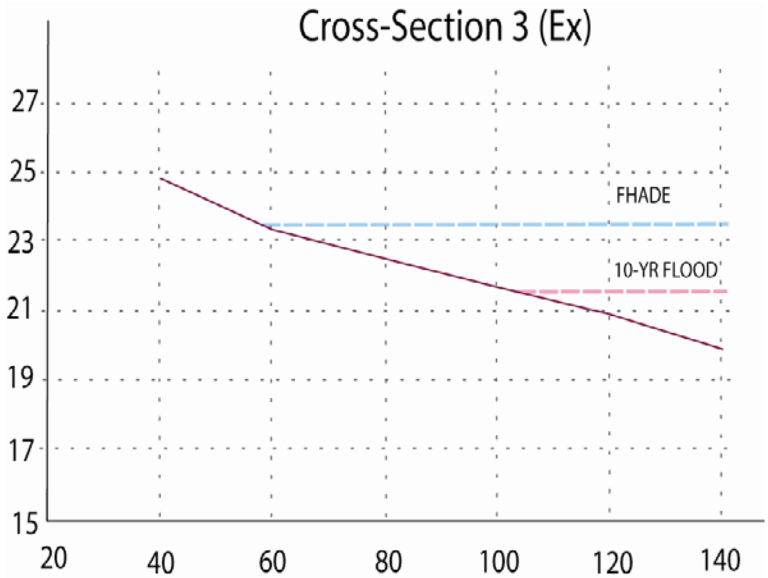
Prepared by or under the supervision of: __________________________
Design Professional

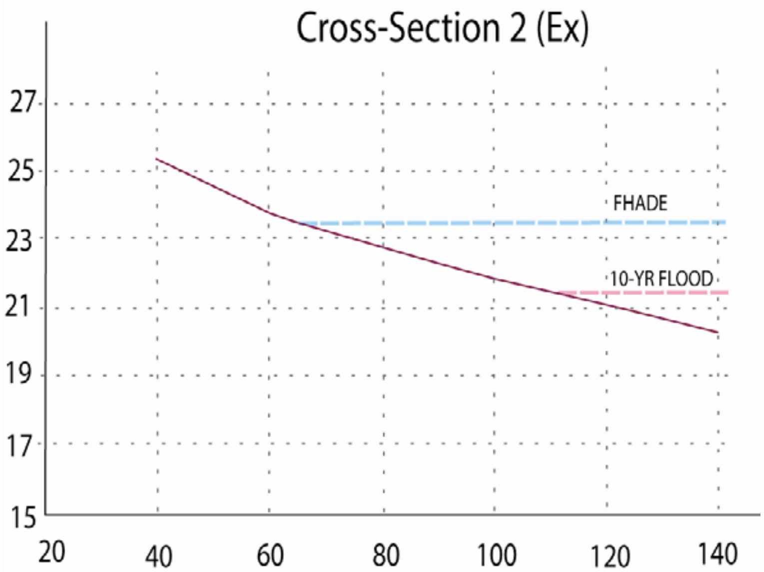
Date: __________________________

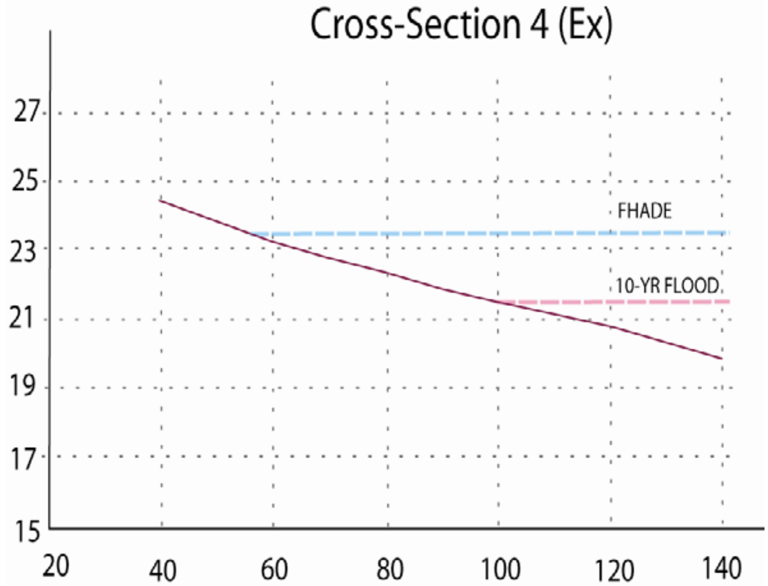
APPENDIX G
CROSS-SECTIONS FOR SECTION 5 EXAMPLE PROJECT

*Note: FHADE = The Flood Hazard Area Design Flood Elevation









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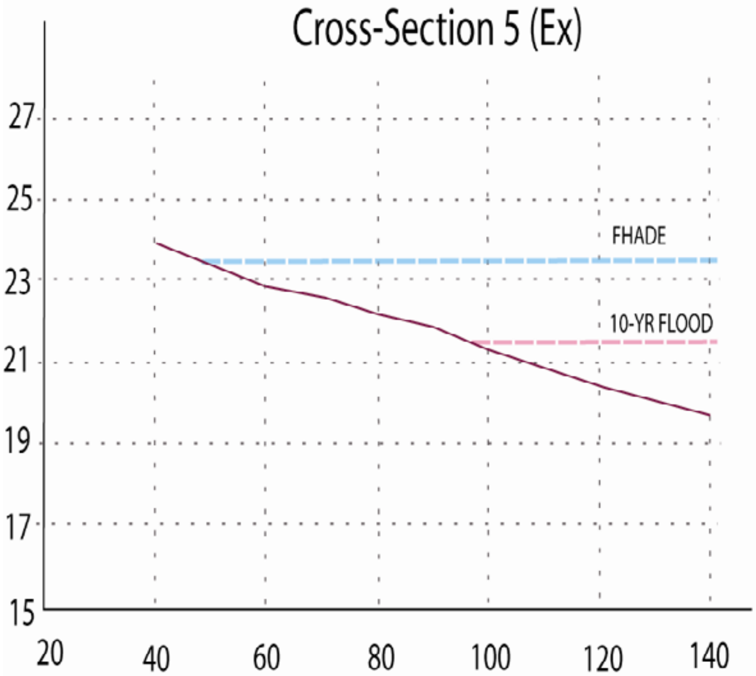

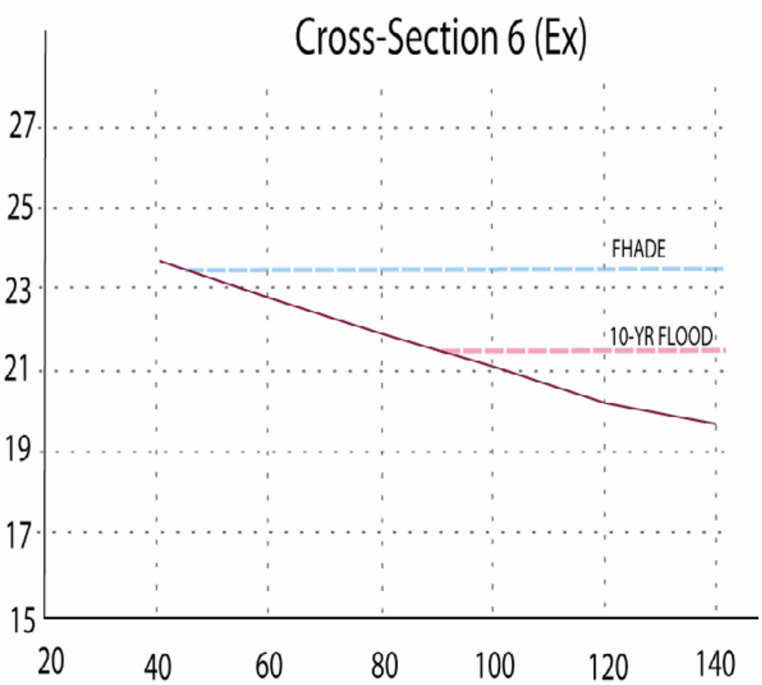

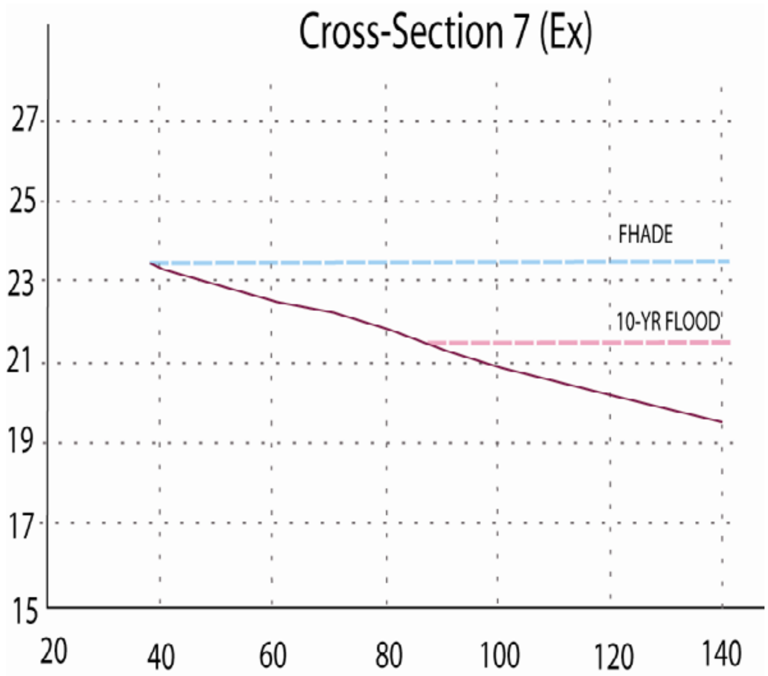

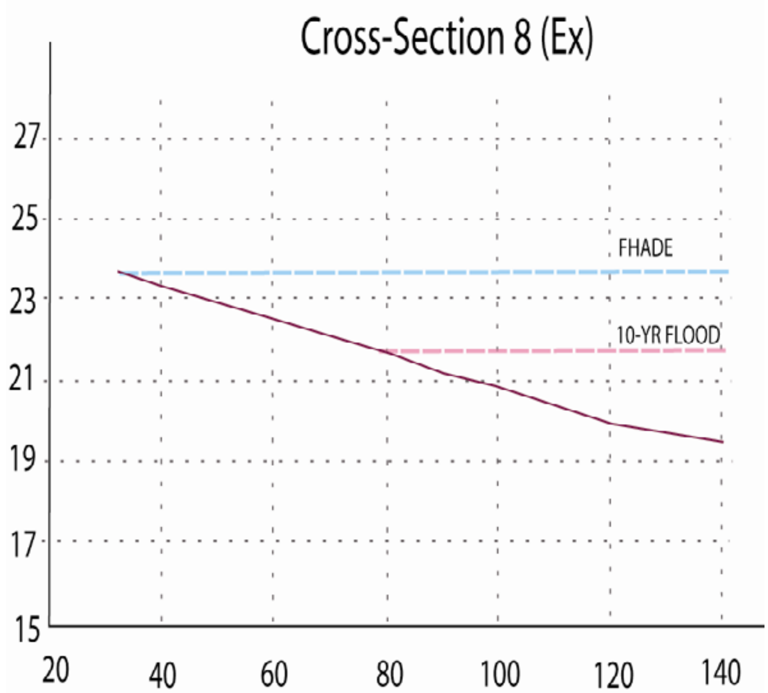

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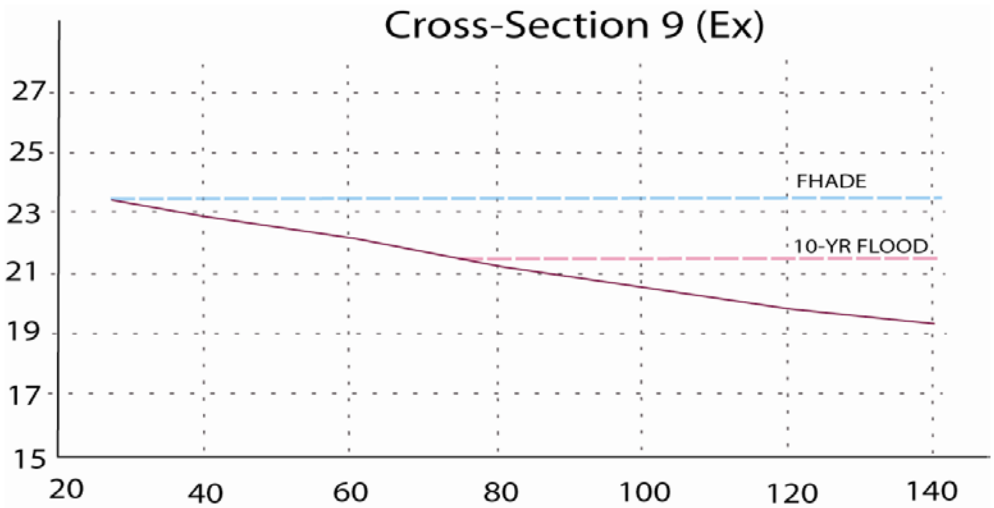

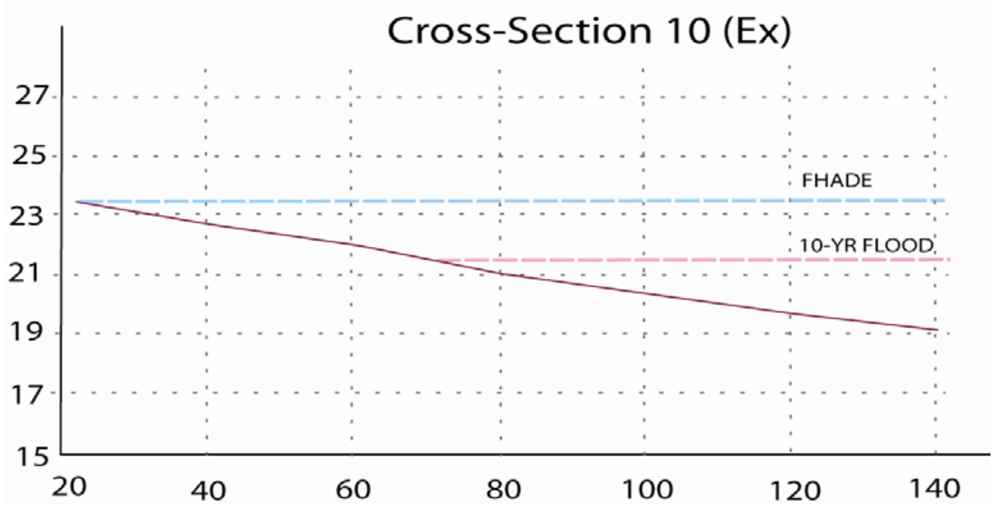

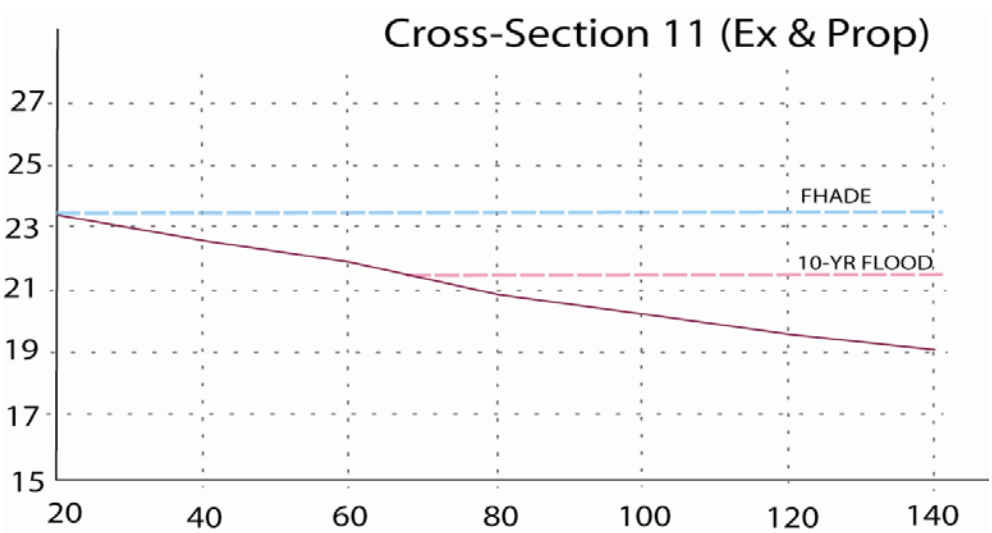

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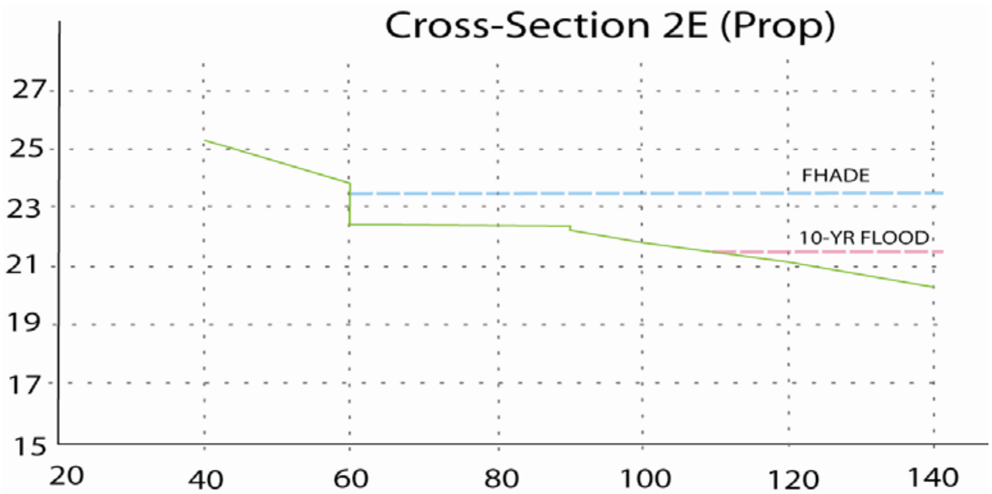

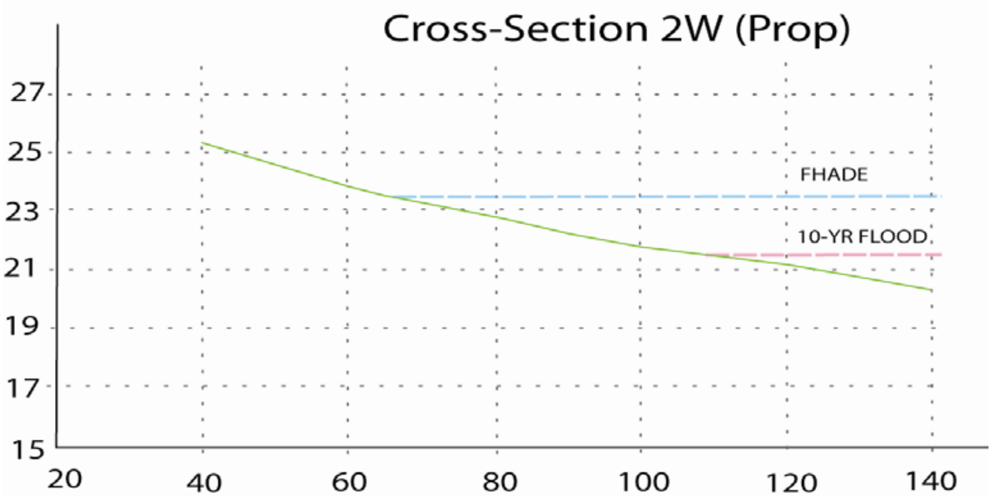

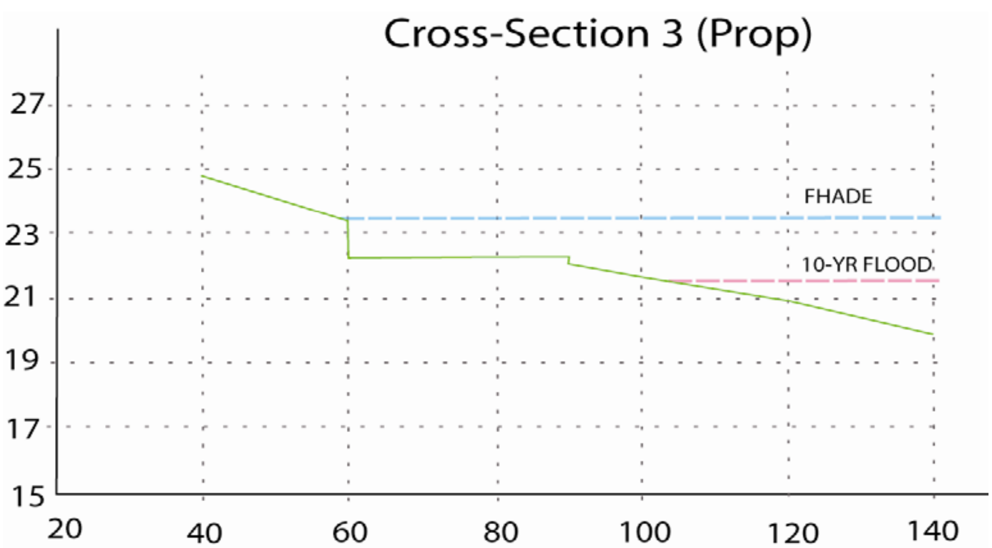

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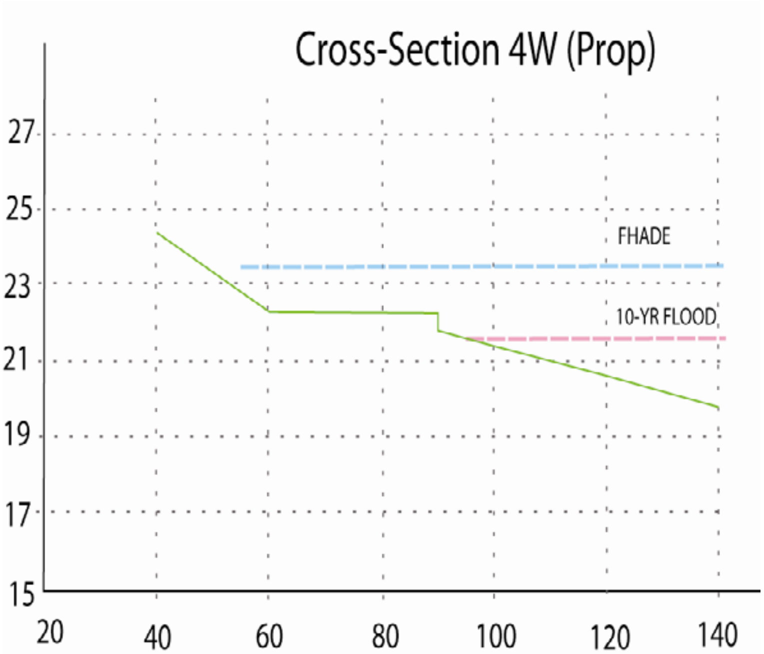

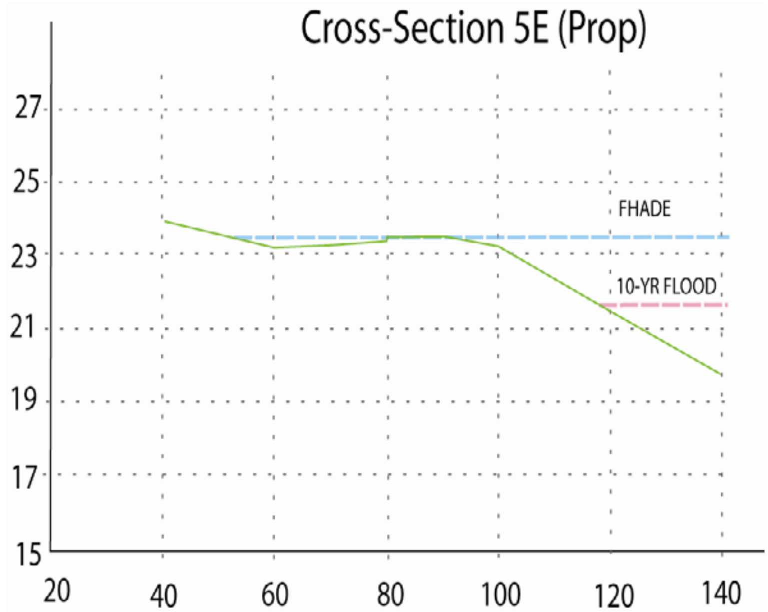

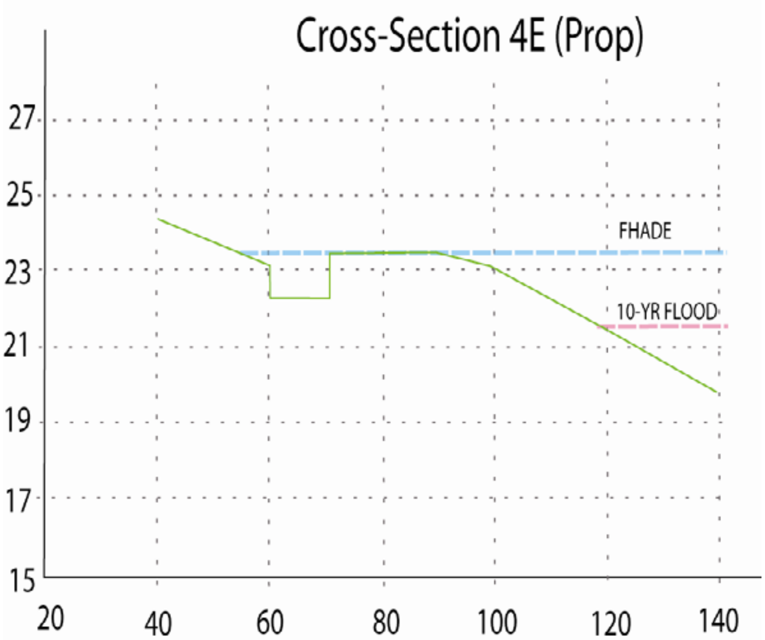

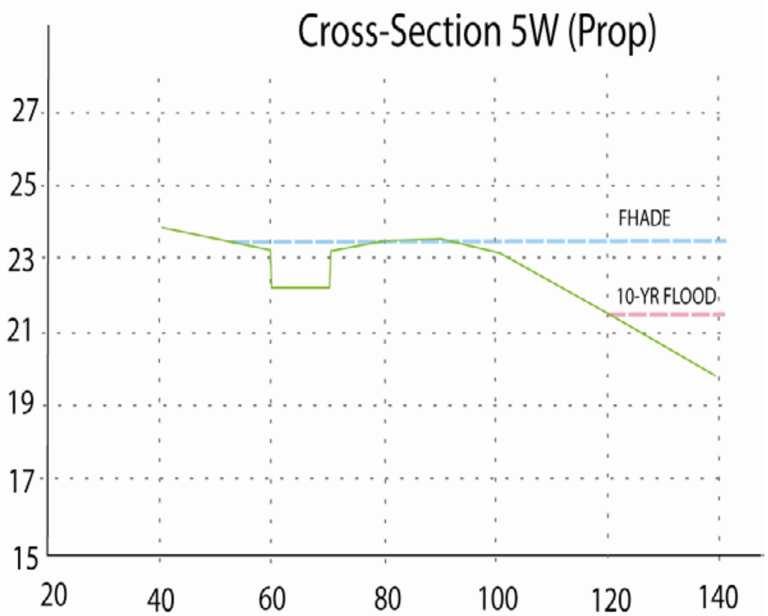

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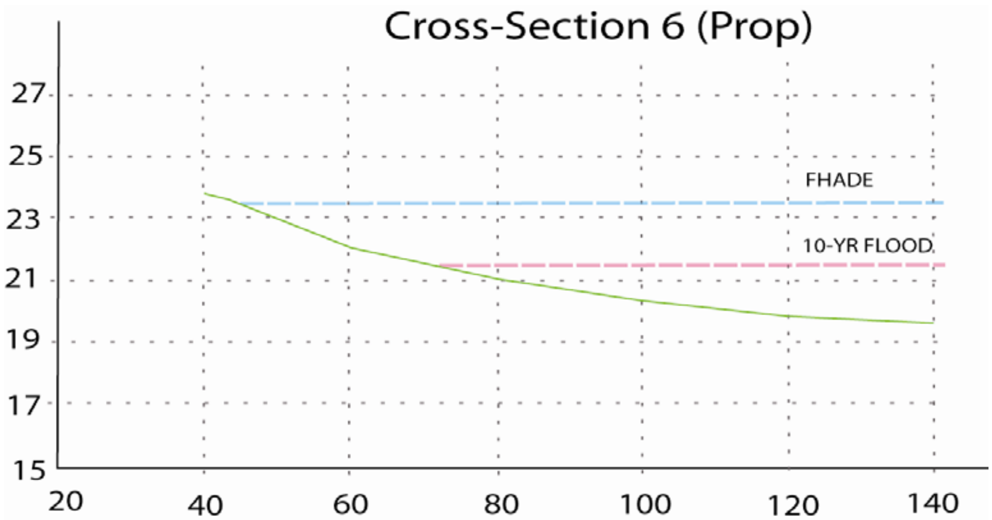

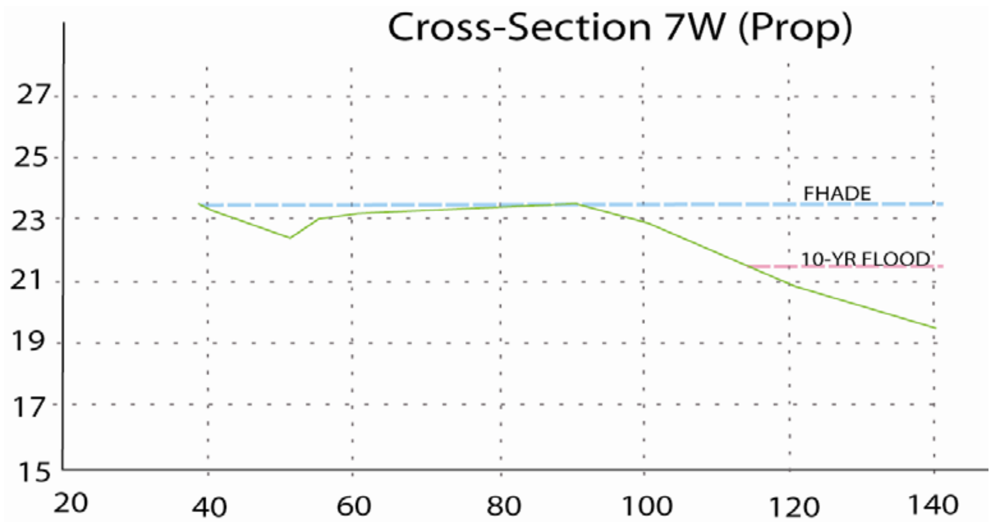

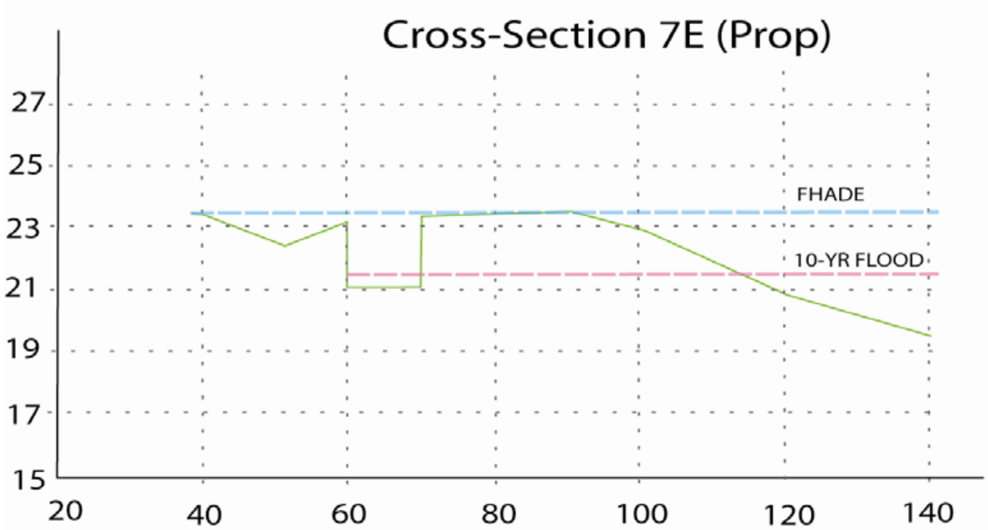

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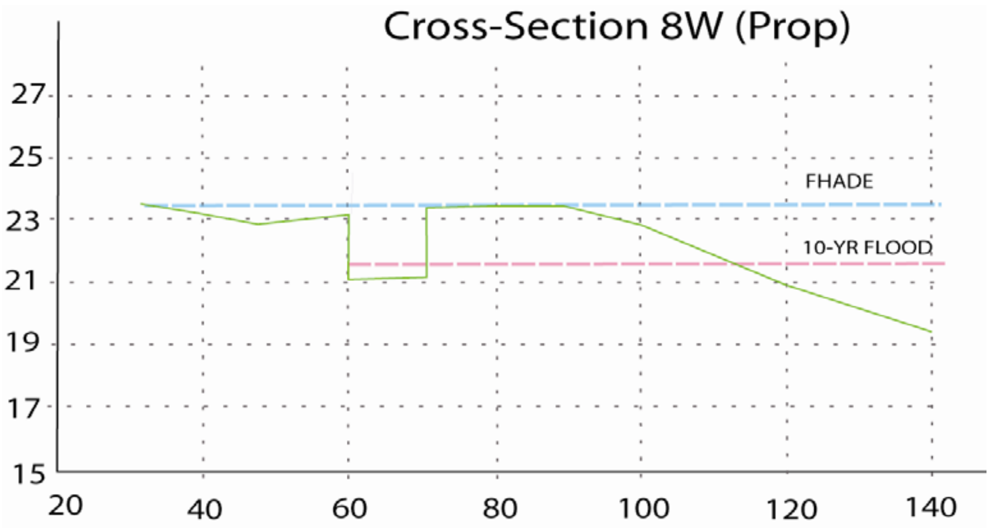

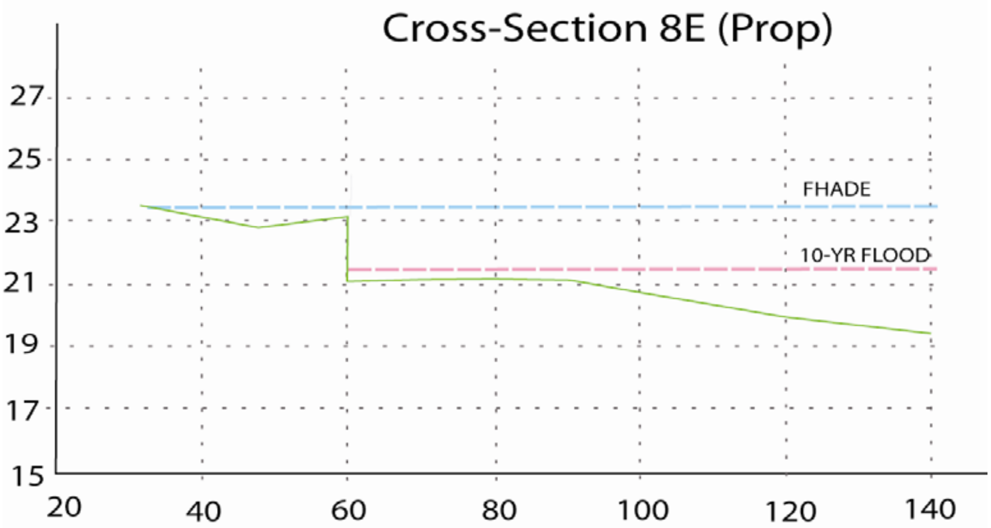

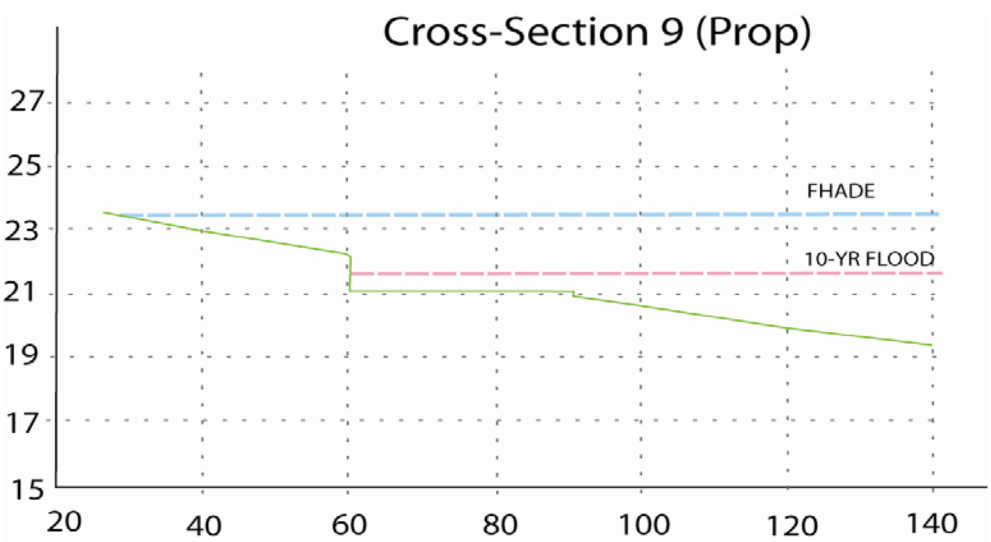

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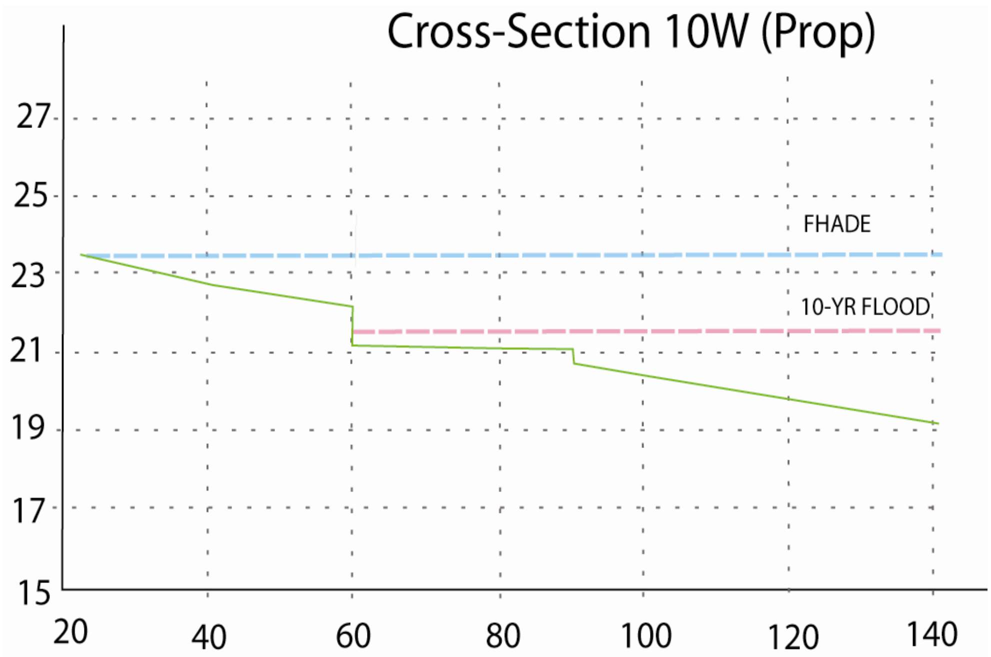

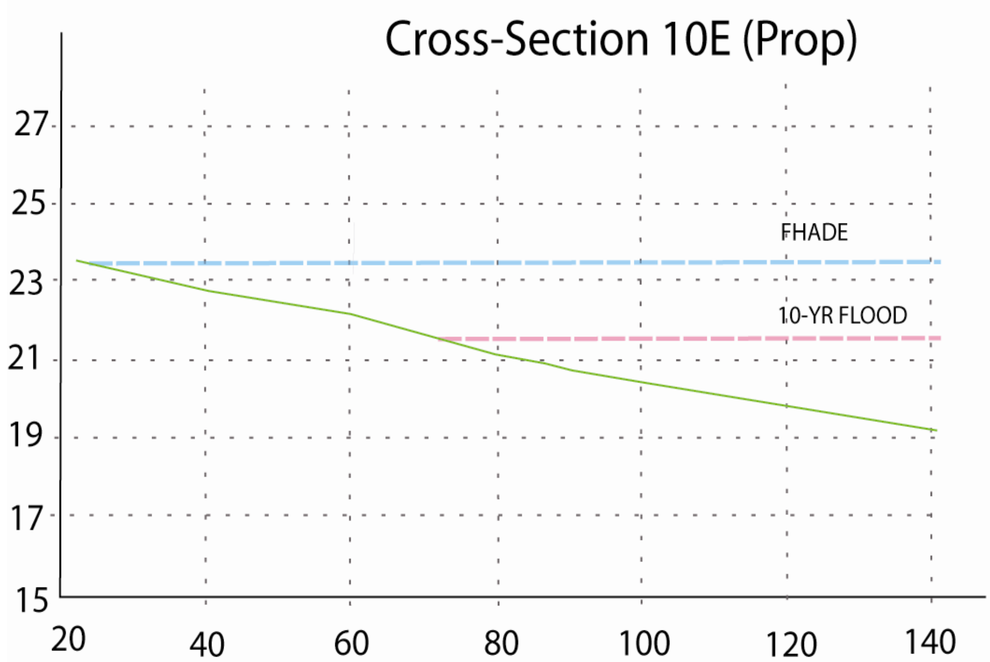

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